HANDBOOK

OF THE

DESTRUCTIVE INSECTS

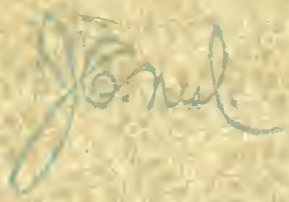
OF

VICTORIA.

PART I.

FRENCH.

A. N. Caudell.



A HANDBOOK

OF THE

DESTRUCTIVE INSECTS

OF

VICTORIA,

WITH NOTES ON THE METHODS TO BE ADOPTED TO CHECK AND EXTIRPATE THEM.

Prepared by Order of the Victorian Department of Agriculture

BY

C. FRENCH, F.L.S., F.R.H.S.,

Government Entomologist.

PART I.

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PREFACE TO PART I.

The want of some practical and popular work bearing upon the question of the Economic Entomology of the colony has long been felt by those who occupy the honorable position of tillers of the soil.

In the opinion of the Government the time for the issue of such a work has now arrived. I believe that this opinion will be shared by the whole of our rural community.

Several causes have recently combined to bring about a greatly increased interest and activity in these practical matters amongst our farmers, orchardists, vignerons, and horticulturists.

In the first place the Government of the colony has formulated and adopted some very liberal measures on the subject, the Hon. the Minister of Agriculture having specially devoted himself to foster and promote new and important departures in the rural industries.

The valuable mass of evidence given by experts before the Royal Commission on Vegetable Products has been rendered available in a series of regular publications. The Secretary for Agriculture has also issued periodical Bulletins. Our veteran scientist, Baron von Mueller, has published several useful and exhaustive works on economic plants. Interest has been aroused by the popular as well as scientific publications of the Field Naturalists' Club of Victoria. This awakening having

taken place, a marked improvement in the agricultural methods of the future may be anticipated.

Here I may perhaps be allowed to say that the necessity for teaching Practical Entomology in the State schools has often impressed me, and I trust the time is not far distant when the sons of the farmers and others interested will be able to distinguish between their garden friends and enemies.

In Victoria, as in the other Australian colonies, the principal troubles which those engaged in the cultivation of the soil have to contend against are droughts, fires, floods, insect and fungus pests. Any work that will contain information whereby the effect of the ravages of any of these may be lessened cannot fail to be welcomed and duly appreciated by those for whom it is intended.

As the Government has done me the honour to intrust me with the preparation of this publication, I should wish to say at the outset that I am not writing a scientific treatise on the insects of Victoria. The work, as its title indicates, is simply a Handbook of Injurious Insects.

It will be issued in Parts, each Part to contain ten or more coloured plates. The object of issuing the work in Parts will be easily understood. The first issue will consist of 9,000 copies.

A short introduction to Entomology is given, this having been taken from Miss Ormerod's well-known and valuable work, "A Manual of Injurious Insects."

A brief account of the classification of insects has been adapted (for reasons shown elsewhere) from Professor Westwood's "A Guide to Modern Classification of Insects," &c., &c.

I have availed myself freely of the works of Messrs. Maskell, Crawford, and others, in which tabular compilations are given of the experiments made on insect pests, which have been recorded chiefly in the various American publications, and have appended some personal observations.

The plates have been produced under my direction by Mr. C. C. Brittlebank, of the Field Naturalists' Club. They are all faithful representations of the objects delineated, the aim being to produce figures which may be understood at a glance.

Where it was possible to obtain specimens of the insects themselves this has been done, and the drawings have been made from nature. But, as in some cases the specimens were not obtainable, the drawings have been made from authenticated plates, and the sources are duly acknowledged.

The lithographing has been executed by the well-known Melbourne firms of Messrs. Troedel and Co. and Messrs. Sands and McDougall, and the printing of the letter-press by the Government Printing Office.

This Handbook is intended to be a practical work, illustrated with useful figures, and contains as few technical descriptions as is consistent with accuracy, so that those who use it may be enabled to readily recognise the various insects with which they may have to deal.

The First Part contains a systematic description, with an account of the noxious insects of the colony which attack Apples, Pears, Apricots, and Cherries; the remaining Parts of the work will be brought out as quickly as possible.

As there are a few other insects which attack the fruits herein mentioned, of which reliable specimens could not be procured, it is intended to describe them in Appendices.

I am glad here to acknowledge the great assistance which I have derived from the perusal of such books as Westwood's Classification of Insects, Buckton's British Aphides, Kirby and Spence's Entomology, the valuable books published by Miss Ormerod, Packard, Stainton, Whitehead, and Walker, including the splendid reports issued by Professor Riley, and other American friends, and, coming nearer home, to the admirable work by Mr. Maskell on the scale insects of New Zealand; the various excellent publications issued by the late Mr. Crawford, of Adelaide; Mr. Oliff, of Sydney; Professor McCoy, of Melbourne; Mr. Tryon, of Brisbane; to say nothing of the valuable journals, &c., published in Melbourne, as also in the other colonies.

To the many kind friends who have assisted me by their advice, and have furnished valuable information, I beg to return my sincere thanks; and as at the present stage it would perhaps be invidious to mention names, I shall do myself the pleasure of an acknowledgment in the concluding number of the book.

The time has arrived when, if we are to fight insect pests successfully, united action must be taken, and knowledge gained by constant vigilance, and by useful and carefully conducted experiments. Only thus can a better knowledge be obtained of the relations of insects to agriculture, viticulture, and horticulture.

I have prepared a chapter on the advantages to be gained by the practical study of insects, as also some remarks on, and directions for, collecting and preservation of same.

The necessity for the protection of our useful birds forms material for another chapter, to which is added a list (with scientific and common names) of the principal kinds to be found in different parts of the colony. And lastly, a copy of the quarantine regulations as carried out in California.

I have followed the excellent plan adopted in America and elsewhere of furnishing some engravings of the principal spray-pumps and other insect-destroying machines many of which can be obtained from the various firms in Melbourne.

Owing to the limited time at my disposal, the absence of many important types of insects for comparison, and for other reasons, errors may have crept in, and I shall be very pleased to receive additional notes or corrections, the receipt of which will be duly and promptly acknowledged.

C. FRENCH.

Melbourne, 1890.

CHAPTER I.

Introduction to Entomology.

*Insects begin their lives either by being hatched from eggs or produced alive by the female; commonly they are hatched in the form known as maggots, caterpillars, or grubs, but they are never generated by decaying vegetables, putrid water, bones, carcasses, dung, or any other matter, dead or alive, excepting their own insect forerunners. They come out of these matters constantly, but, if the observer will watch, he may often see the arrival of the insects, the laying of the eggs, and be able to satisfy himself as to the gradual development and the manner of breeding, and that the progeny is produced by the female insect.

The eggs are usually laid soon after the pairing of the male and female, and are, as a rule, deposited on or near whatever may be the food of the larvæ. They are laid singly or in patches, and are sometimes attached by a gummy secretion to the leaf or whatever they are laid on. Occasionally they are fastened by a short thread, or raised (like the heads of pins) on a stiff foot-stalk of hardened viscid matter. Such insects as insert their eggs in living animal or vegetable matter are furnished with a special egg-laying apparatus or ovipositor, such as a borer, or organs enclosing bristle-like points or saws, by means of which the female pierces a hole, and passes the egg down into the wounded spot.

For the most part insect eggs hatch shortly after they are laid, but sometimes they remain unhatched during the winter, and it is believed that, where circumstances are unfavorable for development, they may remain unhatched for years; but this point is one of those on which more information is needed. They have been

*"Manual of Injurious Insects."—*Ormerod.*

found to endure intense cold without injury, and besides some special and extraordinary instances, it has been found by experiment that insect eggs may be exposed to a temperature lower than that to which they are usually subjected in this country (England), and cold enough to solidify their contents without destroying their powers of hatching.

In a very few cases, insects are partly developed before birth, otherwise, after hatching from the egg, or being produced alive (in the same first stage of development) by the female, insects pass their lives in three different conditions or stages successively.

The first is that in which they are known as maggots, grubs, or caterpillars. In the case of grasshoppers, cockroaches, and some other insects where the young are very much the same shape as the parent, only without wings, they usually go by the parents' name; the young of green-fly are sometimes known as "nits." In this state they are active, voracious, and increase in size, and in this first stage all insects are scientifically termed larvæ.

In the second stage, some orders of insects are usually inactive and cannot feed, as is the case with the chrysalis of the butterfly or moth, or the mummy-like form of the beetle or wasp, with its limbs in distinct sheaths folded down beneath. Some, however, are active and feed, as grasshoppers, cockroaches, aphides (or green-fly), and others resemble the parent insect, excepting that their wings, and for the most part their wing-cases, are not as yet fully formed, and in this second stage all insects are scientifically termed pupæ.

The third stage is that of the perfect insect, in which (whether male or female), or of whatever different kind, as moth, butterfly, beetle, cricket, aphis, &c., it is scientifically termed an imago.

The term larva is from the Latin, meaning a mask or ghost, and signifies that the insect in this stage gives a mere vague idea of its perfect form.

Pupa signifies an infant, and is appropriate to the second stage in which the insect is forming into the

perfect state, but is not fully developed either in its limbs or functions.

Imago signifies the image, the likeness, or an example of the perfect insect. The appropriateness of the scientific names for the first and third stage does not seem very clear, but there is no doubt of the convenience of having some one term by which each different stage of the life of any insect may be described, and these are the words that have been adopted. In the following pages some detail is given of these three successive stages of development:—Larva, maggot, grub, caterpillar, &c. If an insect egg about to hatch is held against the light, or examined as a transparent object by means of a strong magnifier, it will be seen that there is a speck inside which increases in size and becomes more regular in shape daily until it is too large for the egg to contain, when it breaks through this thin film which serves as an eggshell, and often begins life by eating it. This is the larva. It is usually hatched from an egg, but sometimes is produced alive (as some fly-maggots during the summer months).

When it is coloured and has many feet it is usually called a caterpillar. White, fleshy larvæ, such as those of many beetles or flies, are commonly known as grubs or maggots; such as resemble the parent insect are usually known by the name of this insect; but the term of "worm" or "slug" is objectionable, as it leads to confusion.

Larvæ differ very much in appearance; some are legless, cylindrical, or tapering at one end, blunt at the other, with the head (which is soft and furnished with hooks by way of feeding apparatus), capable of being drawn some way back into the maggot; many fly-maggots are of this kind; some larvæ are legless, or with a mere rudiment of a pair of legs on the three rings behind the head, fleshy, smallest at the tail, and furnished with distinct head and jaws; such are some kinds of beetle and wasp-grubs; others are strong and fat, a few inches in length, with three pairs of legs, well developed—as the cockchafer grub.

The caterpillars of the butterflies and moths are often beautifully marked, and have for the most part a pair of articulated feet on each of the three segments behind the head, and pairs of fleshy appendages called sucker-feet on some of the other segments, and at the end of the tail, not exceeding sixteen in all. These "sucker-feet" enable the caterpillars to hold firmly to the twigs they frequent. Proceeding onwards still by number of feet, the caterpillars of the sawflies will be found in many cases to have, besides the three pairs of true feet, five, six, or seven pairs of sucker-feet, and also the pair at the end of the tail (known as the caudal proleg). In some cases (as with grasshoppers, aphides, or green-fly, plant-bugs, &c.) the young in the first stage—whether produced alive or hatched from the egg—much resembles the parent, that is, has a distinct shape of head, with horns, trunk, or thorax, furnished with six legs, and abdomen, and differs mainly in size and in being wingless; but, whether in this shape, or what is known as grub, maggot, or caterpillar, or whatever kind of insect it may belong to in this first stage, it is scientifically a larva.

In this larval stage the insect feeds voraciously and often grows fast, the skin does not expand beyond certain limits, and when this point is arrived at, the larva ceases feeding for a while, the skin loosens, cracks, and is cast off by the creature inside, which comes out in a fresh coat, sometimes like the previous one, sometimes of a different colour or differently marked. This operation is known as moulting, and occurs from time to time till the larva has reached its full growth. The duration of life in the first or larval state is various; in some instances it only extends over a week or two; in some it lasts for a period of three, four, or five years. As far as observations go at present—that is to say, with such kinds as have at present been observed—larvæ are not injured by an amount of cold much beyond what they are commonly called on to bear in this country (England); but they are liable to injury from over supply of moisture, whether from sudden rain in warm weather, or from full

flow of sap of their food-plant, and in this point of their constitutions we have a principle that may help much towards getting rid of them. When the larva has reached its full growth it ceases feeding, and (in the forms known as caterpillar, grub, or maggot) it either goes down into the ground and forms a cell in the earth, or spins a "cocoon" (that is a web) round itself of threads drawn from the lower lip (as in the well-known silkworm cocoon), or in some way it makes or seeks a shelter in which it changes from the state of larva to that of pupa.

Pupa.—*Chrysalis.*

It is much to be regretted that we have no generally-adopted word, excepting "Chrysalis" (which is commonly used in the case of butterflies or moths), to describe the second stage of insect life in which it is changing from the state of larva to that of the complete insect. Whilst in this condition it is for the most part without power of feeding, and perfectly inactive, lying (in the instance of beetles, bees, and wasps, and some others) with the limbs in sheaths folded beneath the breast and body, or (as with butterflies and moths) protected by a hardened coating secreted from the pores of the creature within, when it casts its last larval skin. The method of this change may be easily observed in the case of the caterpillar of the peacock butterfly, which fastens itself by the tail, and then (after its black and silver-spotted skin has cracked) by infinite wriggling and struggling passes this cast-off skin backward, till it is pressed together at the tip of the tail; and the creature from within appears in its new form as a bright green chrysalis, or pupa. It is covered with a moist gummy exudation, which quickly hardens and forms a protecting coat, and in due time (if left unharmed) the butterfly inside would crack through this and appear from within the case; but if it is wished to observe that the beginning of the change to the butterfly form has taken place already, one of these chrysalids may be dropped into a little warm turpentine or turpentine and Canada-balsam, directly the caterpillar skin has been cast;

this will soften the gummy coating just mentioned, and the limbs of the future butterfly will be seen. In some cases the change takes place (as with various kinds of flies) in the hardened skin of the maggot, which may be called a "fly case"; and in some (as with plant-bugs, aphides, grasshoppers, dragon-flies, and some others) this state of pupa is an active one, in which they move and feed, and resemble the perfect insect, excepting in having more or less rudimentary wing-cases.

When the time for development has come, the pupa (if it is one of the active forms, as of a grasshopper, for instance) may be seen looking heavy and stupid; presently the skin of the back splits lengthwise, and through the opening the perfect insect slowly makes its way out of the pupal skin, carefully drawing one limb after another from its precisely-fitting case, the long hind legs the last, till (in the instance observed, in twenty minutes) the perfect grasshopper stands by the side of the film of its former self. Flies press out one end of the fly-case, or leave the sheaths of the limbs and body behind. Beetles and wasps cast the film from their limbs; and butterflies and moths crack open the chrysalis case, and after a short time (during which the wings that had lain undeveloped are expanding) they appear of their full size. The insect is now fully formed; it will grow no more; its internal, as well as external, structure is complete; and it is what is known scientifically as the imago.

Imago.—*Beetle*, *Butterfly*, *Wasp*, *Fly*, *&c.*

This is defined as an animal formed of a series of thirteen rings or segments, breathing by means of tubes (trachcæ) which convey the air from pores in the sides throughout the system, and divided into three chief portions. Of these the first is the head, furnished with horns (antennæ), a mouth (differing very much in form in different kinds of insects), large compound eyes (which consist of many small ones formed into a convex mass on each side of the head), and frequently two or three simple eyes on the top.

The second portion (called the thorax, or sometimes the "trunk") is formed of three rings, bearing a pair of legs attached to each, and having usually a pair of wings on the second and third of the rings; but sometimes the wings are wanting, sometimes there is only one pair.

The third portion (called the abdomen) is formed of the remaining nine rings, and contains the organs of reproduction and most of those of digestion.

Insects in this perfect state are of two sexes, male and female; in some instances (as with wasps and some others) there are imperfectly-developed females, known as "neuters."

After the insect—whether beetle, butterfly, fly, or other kind—has come forth from its chrysalis or fly-case (that is from the pupa), and its limbs have expanded, it grows no more; it is complete, and its remaining work is to support life until it has propagated its species. Usually pairing soon takes place, and the male dies; but the female has great tenacity of life until she has laid her eggs. The length of life, however, is various; in some instances a few days, or even hours, is the extent; in others the insects "hybernate," that is, find some shelter in which they pass the winter, and from which they reappear with the return of warmth and sunshine.

CHAPTER II.

Classification of Insects.

About the classification of insects there is considerable diversity of opinion, and even amongst the most eminent of our scientific entomologists there would appear to be but little chance of some "general" system of classification being agreed upon by all. I have, therefore, adopted the system approved by such eminent entomologists as McLeay, Westwood, and others, as being, to my mind, clear and concise.

Professor Westwood, then, has divided insects into two grand divisions, *Mandibulata* and *Haustellata*. The former (as is the case with beetles, wasps, &c.) feed by means of mandibles (jaws), the latter (as plant bugs, flies, &c.) are provided with "suckers" (*haustellum*), with which they perforate and absorb material for their sustenance. These divisions, or tribes, are again broken up, and are divided into natural orders, genera, and species, the latter sometimes merging into so-called varieties. The following table will the better explain what is meant:—

Natural Orders.	MANDIBULATA.
Coleoptera	Beetles.
Euplexoptera	Earwigs.
Orthoptera	Cockroaches, mantis, locusts, crickets, &c.
Thysanoptera	Thrips.
Neuroptera	Dragon flies, white ants, &c.
Trichoptera	Caddis flies.
Hymenoptera	Bees, wasps, ichneumons, ants, &c.
Strepsiptera	Bee parasites (some).

Natural Orders.	HAUSTELLATA.
Lepidoptera	Butterflies, moths.
Homoptera	Aphis, scale insects, cicadæ, &c.
Heteroptera	Plant bugs, &c.
Aphaniptera	Fleas.
Diptera	Flies, mosquitos, sand-fly, &c.

CHAPTER III.

The Forming of Collections of Economic and other Insects Recommended, with Directions for Collecting and Preserving Same.

The farmer, the fruit-grower, the vigneron, and the forester, who have to contend against the ravages of insect pests, ought surely to know something of the life-history of the insects with which they may have to deal. A few remarks bearing on this subject are offered, with the view of assisting such persons as may feel inclined to know more of insects than they do at present, so as to enable them to distinguish between their "garden" friends and enemies; for this knowledge can only be obtained by the study (even if somewhat imperfectly) of the "manners and customs" of insect life.

It will be a great help to any agriculturist who wishes to follow up this subject successfully to make for himself a collection of the insects of his district.

To commence the study of practical entomology, or to form collections of insects, as a useful and pleasurable pastime, it is not necessary to go to any great outlay in the purchase of books or collecting material, as much of the good work already done has been accomplished by those in humble circumstances, and often under disadvantageous conditions quite unknown to the rural population of newer countries.

It will thus be seen that science and the study of natural history is open to all—rich and poor, humble as well as great—so that none need be afraid to undertake at least something useful, more especially in a new country, where the field for observation is so vast, and the interests at stake of such great national importance to the rural portion of our community. We must be up and doing.

An enterprising American fruit-grower, as quoted by Mathew Cooke, in his valuable book,* has said :—"Our watchword must ever be, 'Onward and upward, and falter not, although difficulties apparently insurmountable arise: he who will may overcome them.' The enterprising fruit-growers of California are filled with a spirit that no power on earth can curb. It falters not at misfortune's door or any obstacle to success, but boldly advances and removes them all; at least, it has been so, and must ever be. The time was when our glorious climate, fruitful soil, and exemption from all diseases and pests, made our Golden State the wonder of all who were conversant with its fruit and flowers. Now, alas, the spoiler's hand is felt; a change has come over the spirit of our dream. It seems as though all that is detrimental to the fruit interest is here or coming, making eternal vigilance the price of success in this, the industry of the State. The time has come when every one who by this occupation would thrive will find ceaseless use for head and hand; even then the fittest only can survive. Who will supinely sit and see misfortune spoil the results of years of toil, while others gird on their armour with energies stimulated by the presence of the forces arrayed against them on every hand?"

It has been remarked previously that the necessary apparatus for forming collections of insects for ordinary practical purposes need not be of an expensive kind. A few yards of mosquito or other net will, with two or three small hoops and a handle, make valuable nets for capturing insects whilst on the wing. An umbrella, "for shaking," a few bottles of methylated spirit (gin or whisky will suffice if the methylated spirit is not obtainable), a wide-mouthed bottle or jar—say a salt jar, into which has been placed some cyanide of potassium (*a deadly poison, which should be used with caution*). To prepare the materials for the cyanide bottle—The cyanide should be crushed and mixed with plaster of Paris, say three parts of the latter to one part of the cyanide. Moisten, and

* "Injurious Insects."

place in a wide-mouthed and tightly-corked jar, and it is then, when firmly set, ready for use. This should be kept out of the way of children.

A few closely-fitting wooden boxes (cigar boxes will, if cut down the Middle and hinged with linen and made into a "double-box," answer very well); some pins; a few setting-boards, which anyone can make for himself out of a piece of deal and a few strips of cork; forceps (those with bent joints are the best); some napthaline, carbolic acid, or camphor will also be required for the purpose of keeping out minute insects, as ants, mites, &c., which, if undisturbed, often play great havoc with such collections.

For the permanent preservation of Insects, both the cork and the insects themselves should be dipped in a solution of corrosive sublimate, and dried before placing in the cabinet or in store boxes.

Small moths, as the cabbage moth, clothes moth, wheat moth, potato moth, and others belonging to the great group of the Tincina, should be pinned in the box immediately after capture, as they soon become brittle and are easily broken. The best method of capturing the micro (small) lepidoptera is to hold a bottle containing the cyanide (which is known to collectors as the killing bottle) under the specimens while in the net, as the insect will then drop into the bottle and be instantly suffocated, without damage to the wings, limbs, &c.

For the capture of the larger kind of moths, butterflies, &c., the net must also be used, as a specimen should never be handled if it is possible to avoid doing so, as the scales on the wings are very easily rubbed off, to the permanent disfigurement of the specimen, but a little care and practice will soon enable any one to overcome these difficulties. In sending away the larger moths and butterflies, the specimens, after having been killed in the usual manner, should be folded neatly away in papers (old envelopes will do) and packed in boxes; and these specimens can, by damping on blotting-paper, be relaxed and softened, and may then be set out in their natural positions.

When collecting insects (and particularly those of economic interest) the larvæ, chrysalids (also eggs, if possible), with portions of the plant on which the insect feeds, should be taken, and any interesting matter, as changes of state, habits, data, &c., should be carefully noted for future reference, and for this purpose a "Register" book should be kept. This trouble would soon repay itself, and could not fail to be a source of useful interest and pleasure, more especially to the young people of both sexes. The principal advantages expected to be derived from a study of Entomology by those engaged in rural pursuits, is to help them to a better acquaintance with insects in general, and economic insects in particular; to assist them in discriminating between the destructive and useful kinds, and to enable them to better understand the value of and perhaps appreciate the many books written on the subject; also, by finding out the habits of those creatures, they may be able to devise means for their prevention or eradication. If this much can be accomplished, who shall say that the advantages gained are not worth more than the trouble taken? This branch of the Victorian Department of Agriculture has been created for the purpose of assisting those persons above indicated, and is at the service of those who desire to avail themselves of its privileges.

Insects are to be found nearly everywhere—under the bark of trees, on trees, under logs, stones, dung, on flowers, leaves, on fences, in fruit, on roots, in the soil; in fact, there are few places in the world where insects of some kind or other are not to be found.

Butterflies and moths, if reared from the caterpillars, are, as a rule, more perfect than those taken whilst on the wing, and the rearing of such will afford much useful and pleasurable instruction to those who can devote a little of their spare time for the purpose.

Beetles and many other kinds of insects may at once be placed in spirits, but should never be placed together while alive in boxes, as they often damage each other so much as to be next to useless for specimens.

Wasps and other stinging insects should be captured with a net, and from thence transferred to the killing bottle.

Minute beetles, &c., can be gummed on to small pieces of card, the locality, date of capture, &c., added on a label attached to the pin.

In forwarding specimens for identification and report, great care should be taken in packing for post, and tin boxes should always be used for the purpose. The address should be written on a label, and not on the box; this lessens the chances of damage whilst passing through the Post Office.

CHAPTER IV.

On the Necessity for the Preservation of Our Insect-destroying Birds, with an Alphabetical List of the Principal Kinds.

To all who are engaged in either farming or fruit-growing, the preservation of our useful friends, the insect-destroying birds, is in my opinion of the very greatest importance.

Nature maintains a balance between the numbers of the birds, beasts, insects, plants, &c., in any district. If by artificial means we destroy this balance, immediately intolerable numbers of some kinds remain with us, and we have to expend much money and labour to rid ourselves of the swarm which nature was ready to dispose of for us gratis.

Some writer has well said, as quoted by Mr. Tryon in his valuable book on the fungus and insect pests of Queensland—"If the arrangements of nature were left undisturbed, the result would be a wholesome equilibrium of destruction. The birds would kill so many insects that the insects could not kill too many plants. One class is a match for the other. A certain insect was found to lay 2,000 eggs, but a single 'Tom-tit' was found to eat 200,000 eggs in a year. A swallow devours 543 insects in a day, eggs and all."

There is the whole case in a nutshell. The birds will do yeoman service, and ask for no wages.

The question will naturally be asked, How and by what means is the wholesale destruction of our insectivorous birds to be checked? This would seem to be a somewhat difficult question to answer, for have we not already game laws, but are they carried out? I am afraid not, and thus the good intentions of those by whom they were introduced have been frustrated.

To secure active co-operation in the direction of the preservation of insectivorous birds, we must be able by the aid of the stuffed specimens themselves to show those interested the difference between the noxious and the beneficial; to point out to those persons who are engaged in our great rural industries that their interest lies in uniting, as in the case of insect-pests, to maintain the balance which nature has given us, and more especially to endeavour to impress upon the young people the necessity for preserving certain birds from destruction.

Those unaccustomed to dissecting birds can have but a faint idea of the enormous quantity of insects many even of the smaller birds devour, and a better acquaintance with both birds and insects would, I am sure, tend to prevent such wholesale slaughter. The chief enemies of birds are the itinerant sportsmen, who on holidays scour the country in all directions, until very little is left of the bird-life of former days. In the case of such birds as Parrots, Leatherheads, Sparrows, &c., which are destructive to either fruit or grain, those interested will of course know best how to deal with them.

But a very large number of our native birds feed solely on insects, *and every such bird is always on the watch to protect the farmer's crops.* Let this fact be once realized by the rural population and there will be a chance of saving the birds. If once the birds become extinct here, it will be almost, perhaps quite, impossible to replace them.

The excellent charts in the schools ought to be the means of enabling persons to distinguish many kinds of birds which should be protected and preserved as being of essential service to all cultivators, and these excellent bird illustrations, could, with great advantage be added to.

The importation of the insect-destroying birds of other countries would also be advantageous, but in so doing great care must be used to make sure of the particular kinds we propose to introduce, so as to enable us to guard against a repetition of former and often most disastrous mistakes.

Appended is a list of those birds which have been proved by competent authorities to be destroyers of insects in our colony, and I have to thank Messrs. A. J. Campbell, D. Le Souef, and A. Coles for their assistance in the compilation of the list.

The common names are those generally adopted, and which for convenience sake are placed before the scientific names.

ALPHABETICAL LIST OF THE PRINCIPAL INSECTIVOROUS BIRDS OF VICTORIA.

Common Name.	Scientific Name.
Acanthiza (Chestnut-rumped)	Acanthiza uropygialis.
Acanthiza (Little)	„ nana.
Acanthiza (Little Brown)	„ pusilla.
Acanthiza (Red-rumped)	„ pyrrhopygia.
Acanthiza (Striated)	„ lineata.
Bee-eater (Australian)	Merops ornatus.
Bristle Bird	Sphenura brachyptera.
Bristle Bird (Rufous-headed)	„ Broadbenti.
Bustard, or Wild Turkey	Choriotis Australis.
Calamanthus (Field)	Calamanthus campestris.
Calamanthus (Striated)	„ fuliginosus.
Campephaga (Jardine's)	Edoliisoma teniurostre.
Campephaga (White-shouldered)	„ tricolor.
Cincloramphus (Black-breasted)	Cincloramphus cantillans.
Cincloramphus (Brown)	„ cruralis.
Cincloramphus (Rufous-tinted)	Ptenædus rufescens.
Chthonicola (Little)	Chthonicola sagittata.
Coach-whip Bird	Psophodes crepitans.
Crow-shrike (Black-throated)	Cracticus robustus.
Crow-shrike (Collared)	„ torquatus.
Crow-shrike (Grey)	Strepera cuneicaudota.
Crow-shrike (Hill)	„ melanoptera.
Crow-shrike (Pied)	„ graculina.
Crow-shrike (Sooty)	„ fuliginosa.
Crow-shrike (White-backed)	Gymnorhina leuconota.
Cuckoo (Black-eared)	Mesocalius palliolatus.
Cuckoo (Bronze)	Chalcites plagosus.
Cuckoo (Brush)	Cuculus insperatus.
Cuckoo (Fan-tailed)	„ flabelliformis.
Cuckoo (Narrow-billed Bronze)	Chalcites basalis.
Cuckoo (Pallid or Unadorned)	Cuculus pallidus.
Diamond Bird (Allied Pardalote)	Pardalotus affinis.

Common Name.	Scientific Name.
Diamond Bird (Spotted Pardalote)	Pardalotus punctatus.
Diamond Bird (Striated Pardalote)	„ ornatus.
Diamond Bird (Yellow-rumped Pardalote)	„ xanthopygialis.
Duck (Whistling-tree)	Dendrocygna vagaies.
Doller Bird (Australian Roller)	Eurostomus Pacificus.
Ephthianura (Orange-fronted)	Ephthianura aurifrons.
Ephthianura (Tri-coloured)	„ tricolor.
Ephthianura (White-fronted)	„ albifrons.
Fantail (Black)	Sauloprocta motacilloides.
Fantail (Rufous-fronted)	Rhipidura rufifrons.
Fantail (White-shafted)	„ albiscapa.
Fly-catcher (Brown)	Micræca fascinans.
Fly-catcher (Carniated)	Monarcha melanopsis.
Fly-catcher (Leaden-coloured)	Miagra rubecula.
Fly-catcher (Restless)	Seisura inquieta.
Fly-catcher (Shining)	Miagra nitida.
Geobasileus (Buff-rumped)	Geobasileus reguloides.
Geobasileus (Yellow-rumped)	„ chrysorrhæa.
Gerygone (Brown)	Gerygone fusca.
Grass-bird (Little)	Sphenœacus gramineus.
Graculus (Black-faced)	Graculus melanops.
Graculus (Ground)	Pteropodocys phasianella.
Graculus (Varied)	Graculus mentalis.
Hylacola (Red-rumped)	Hylacola pyrrhopygia.
Ibis (Glossy)	Ibis falcinellus.
Ibis (Straw-necked)	Geronticus spinicollis.
Ibis (White)	Threskiornis strictipennis.
Jackass (Great Brown Kingfisher or Laughing)	Dacelo gigas.
Kestrel (Nankeen)	Tinnunculus cenchroides.
Kingfisher (Azure)	Alcyone azurea.
Kingfisher (Red-backed)	Halcyon pyrrhopygius.
Kingfisher (Sacred)	Halcyon sanctus.
Lark (Horsfield's Bush)	Mirafra Horsfieldii.
Lyre-Bird (Queen Victoria's)	Menura Victoriæ.
Magpie (Piping Crow-shrike)	Gymnorhina tibicen.
Magpie Lark (Pied Grallina)	Grallina picata.
Martin (Fairy)	Lagenoplastes ariel.
Night-jar (Owlet)	Ægotheles Novæ-Hollandiæ.
Night-jar (White-throated)	Eurostopodus albogularis.
Night-jar (Spotted)	„ guttatus.
Oreoica (Crested)	Oreoica cristata.
Owl (Grass)	Strix candida.
Petrel (Blue)	Halobœna cerulea.
Pigeon (Top-knot)	Lopholaimus antarcticus.
Pipit (Australian)	Anthus Australis.

Common Name.	Scientific Name.
Plover (Southern Stone)	Ædicnemus grallarius.
Podargus (Cuvier's)	Podargus Cuvieri.
Podargus (Tawny-shouldered)	„ strigoides.
Pomatostomus (Chesnut-crowned)	Pomatostomus ruficeps.
Pomatostomus (Temporal)	„ temporalis.
Pomatostomus (White-eyebrowed)	„ superciliosus.
Pycnoptilus (Downy)	Pycnoptilus floccosus.
Red Throat	Pyrrholæmus brunneus.
Robin (Flame-breasted)	Petrœca phœnicea.
Robin (Hooded or Pied)	Melanodryas bicolor.
Robin (Pink-breasted Wood)	Erythrodryas rhodinogaster.
Robin (Red-capped)	Petrœca Goodenovii.
Robin (Rose-breasted Wood)	Erythrodryas rosea.
Robin (Scarlet-breasted)	Petrœca leggii.
Robin (Scrub)	Drymodes brunneopygia.
Robin (Yellow-breasted)	Eopsaltria Australis.
Sericornis (Allied)	Sericornis osculans.
Sericornis (Sombre-coloured)	„ humilis.
Sericornis (Spotted)	„ maculatus.
Sericornis (White-fronted)	„ frontalis.
Shrike (Spangled Dronga)	Chibia bracteata.
Shrike-Thrush (Harmonious)	Collyriocincla harmonica.
Shrike-Tit (Frontal)	Falcunculus frontatus.
Sittella (Black-capped)	Sittella pileata.
Sittella (Orange-winged)	„ chrysoptera.
Smicrornis (Short-billed)	Smicrornis brevirostris.
Swallow (Masked Wood)	Artamus personatus.
Swallow (Tree)	Hydrochelidon nigricans.
Swallow (Welcome)	Hirundo frontalis
Swallow (White-breasted)	Cheramæca leucosternon.
Swallow (White-eyebrowed Wood)	Artamus superciliosus.
Swallow (White-rumped Wood)	„ leucopygialis.
Swallow (Wood)	„ sordidus.
Swift (Australian)	Cypselus pacificus.
Swift (Spine-tailed)	Chætura candacuta.
Thickhead (Gilbert's)	Pachycephala Gilberti.
Thickhead (Olivaceous)	„ olivacea.
Thickhead (Rufous-breasted)	„ rufiventris.
Thickhead (White-throated)	„ gutturalis.
Thrush (Chesnut-backed)	Cinclosoma castaneonotum
Thrush (Cinnamon-coloured)	„ cinnamomeum.
Thrush (Spotted-ground)	„ punctatum.
Thrush (Mountain)	Geocichla lunulata.
Tree-creeper (Brown)	Climacteris scandens.
Tree-creeper (Red-eyebrowed)	„ erythrops.
Tree-creeper (White-throated)	„ leucophæa.
Warbler (Black-backed Superb)	Malurus melanotus.

Common Name.	Scientific Name.
Warbler (Lambert's Superb) - -	Malurus Lamberti.
Warbler (Long-tailed Superb) -	„ Gouldii.
Warbler (Reed) - - - -	Calamoherpe Australis.
Warbler (Rufous-headed Grass) -	Cisticola ruficeps.
Warbler (White-winged Superb) -	Malurus leucopterus.
Warbler (Blue-wren or Superb) -	„ cyaneus.
Wedgebill (Crested) - - -	Sphenostoma cristata.
Wren (Emu) - - - -	Stipiturus malachurus.
Wren (Striated) - - - -	Amytis striatus.
Wren (Textile) - - - -	„ textilis
Xerophila (White-faced) - -	Xerophila leucopsis.

CHAPTER V.

Horticultural Quarantine Rules.

When we consider that the principal of the insect pests in Victoria have been imported from other countries, does it not behove us to take some steps to prevent a repetition of this very dangerous state of affairs? And I unhesitatingly affirm that, if some prohibitive measures against the wholesale introduction of both insect and fungus diseases are not forthcoming, it will be a bad look-out for our farmers and orchardists. And to draw attention to this important subject, I have included in this part of the handbook a copy of the following rules as carried out by the State Board of Viticultural Commissioners of California:—

"Quarantine rules and regulations for the protection of fruit and fruit trees from insect pests, namely, insects injurious to fruit and fruit trees, authorized and approved by the State Board of Viticultural Commissioners of California. In pursuance of an Act entitled 'An Act to define and enlarge the duties and powers of the Board of State Viticultural Commissioners, and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture,' approved March 4, 1881, the chief executive horticultural and health officer may appoint local resident inspectors in any and all of the fruit-growing regions of the State, whose duties shall be as provided in section 4 of an Act entitled 'An Act to define and enlarge the duties and powers of the Board of State Viticultural Commissioners, and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture,' provided that there shall be no compensation for such services of inspection excepting a fee, not to exceed one dollar for each certificate of disinfection, in case of compliance with quarantine regulations, and to exceed five dollars for each certificate of disinfection after

seizure for non-compliance; provided, however, such inspector may be employed at the option of the owners of property requiring disinfection to disinfect the same. And also said local resident inspectors will be entitled to such other fees as are provided for in cases of conviction and seizures.

1. All tree or plant cuttings, grafts or scions, plants or trees of any kind, infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, that are known to be injurious to fruit or fruit trees, and liable to spread contagion; or any tree or plant cuttings, grafts, scions, plants, or trees of any kind, grown or planted in any county or district within the State of California, in which trees or plants, in orchards, nurseries, or places, are known to be infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, that are known to be injurious to fruit or fruit trees, and liable to spread contagion, are hereby required to be disinfected before removal for distribution or transportation from any orchard, nursery, or place where said tree or plant, cuttings, grafts, or scions, plants, or trees of any kind are grown, or offered for sale or gift, as hereinafter provided.

2. All trees or plant cuttings, grafts, or scions, plants, or trees of any kind, imported or brought into this State from any foreign country, or from any of the United States or Territories, are hereby required to be disinfected immediately after their arrival in this State, and before being offered for sale or removed for distribution or transportation, as hereinafter described; provided, that if on examination of any such importations by a local resident inspector, or the chief executive horticultural officer, a bill of health is certified to by such examining officer, then disinfection will be unnecessary.

3. Fruit of any kind infested by any species of scale insect or scale insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit and fruit trees, and liable to spread contagion, is hereby required to be disinfected, as hereinafter provided, before removal off premises where grown for the purpose of sale, gift, distribution, or transportation.

4. Fruit of any kind infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, imported or brought into this State from any foreign country, or from any of the United States or Territories, is hereby prohibited from being offered for sale, gift, distribution, or transportation.

5. Fruit of any kind infested by the insect known as codlin moth, or its larvæ or pupæ, is hereby prohibited from being kept in bulk, or in packages or boxes of any kind, in any orchard, storeroom, salesroom, or place, or being dried for food or any other purposes, or being removed for sale, gift, distribution, or transportation.

6. Fruit boxes, packages, or baskets used for shipping fruit to any destination are hereby required to be disinfected, as hereinafter provided, previous to their being returned to any orchard, storeroom, salesroom, or place to be used for storage, shipping, or any other purpose.

7. Transportable material of any kind infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, is hereby prohibited from being offered for sale, gift, distribution, or transportation.

8. Tree or plant cuttings, grafts, scions, plants, or trees of any kind may be disinfected by dipping in a solution composed of not less than one pound (1lb.) of commercial concentrated lye to each and every two (2) gallons of water used as such disinfectant, or in any other manner satisfactory to the chief executive horticultural and health officer.

9. Empty fruit boxes, packages, or baskets may be disinfected by dipping in boiling water and allowed to remain in said boiling water not less than two minutes, said boiling water used as such disinfectant to contain, in solution, not less than one pound (1lb.) of commercial potash, or three-fourths ($\frac{3}{4}$) of one pound (1lb.) of concentrated lye, to each and every twenty gallons of water, or in any other manner satisfactory to the chief executive horticultural and health officer.

10. Fruit on deciduous and citrus trees infested by any species of scale insect or scale insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, may be disinfected before removal from the tree, or from the premises where grown, by washing or thoroughly spraying said fruit with a solution composed of one pound (1lb.) of whale-oil soap and one-fourth of one pound of flour of sulphur to each and every one and one-quarter ($1\frac{1}{4}$) gallons of water used as such disinfectant, or in any other manner satisfactory to the chief executive horticultural and health officer.

11. Owners of fruit of any kind grown in any orchard, nursery, or place in which trees or plants are known to be infested with any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, and all persons in possession thereof, or offering for sale, gift, distribution, or transportation, are hereby required to procure a certificate of disinfection before removal for sale, gift, distribution, or transportation.

12. Any tree or plant cuttings, scions, plants, or trees of any kind, empty fruit boxes, fruit packages, or fruit baskets, or transferable material of any kind, offered for sale, gift, distribution, or transportation, in violation of the quarantine rules and regulations for the protection of fruit and fruit trees, approved by the Board of State Viticultural Commissioners, may be seized by the Chief Executive Horticultural and Health Officer, or by any of the local resident inspectors appointed by him; said seizure to be the taking possession thereof, and holding for disinfection, or for an order of condemnation by a court of jurisdiction.

13. Any person violating the above quarantine rules and regulations shall be deemed guilty of a misdemeanour, and upon conviction thereof shall be punishable by a fine of not less than twenty-five nor more than one hundred dollars.—Mathew Cooke, Chief Executive Horticultural and Health Officer.—Sacramento, November 12, 1881."

PLATE I.

"Woolly Aphis, or American Blight" (Schizoneura lanigera).

Fig.

1. Portion of stem of apple, showing downy covering to young insects. (From nature.)

2A. Wingless larvæ; upper view. Highly magnified. (From nature.)

2B. Wingless larvæ; under view. Highly magnified. (From nature.)

3. Winged male; upper view. Highly magnified. (After Cooke.)

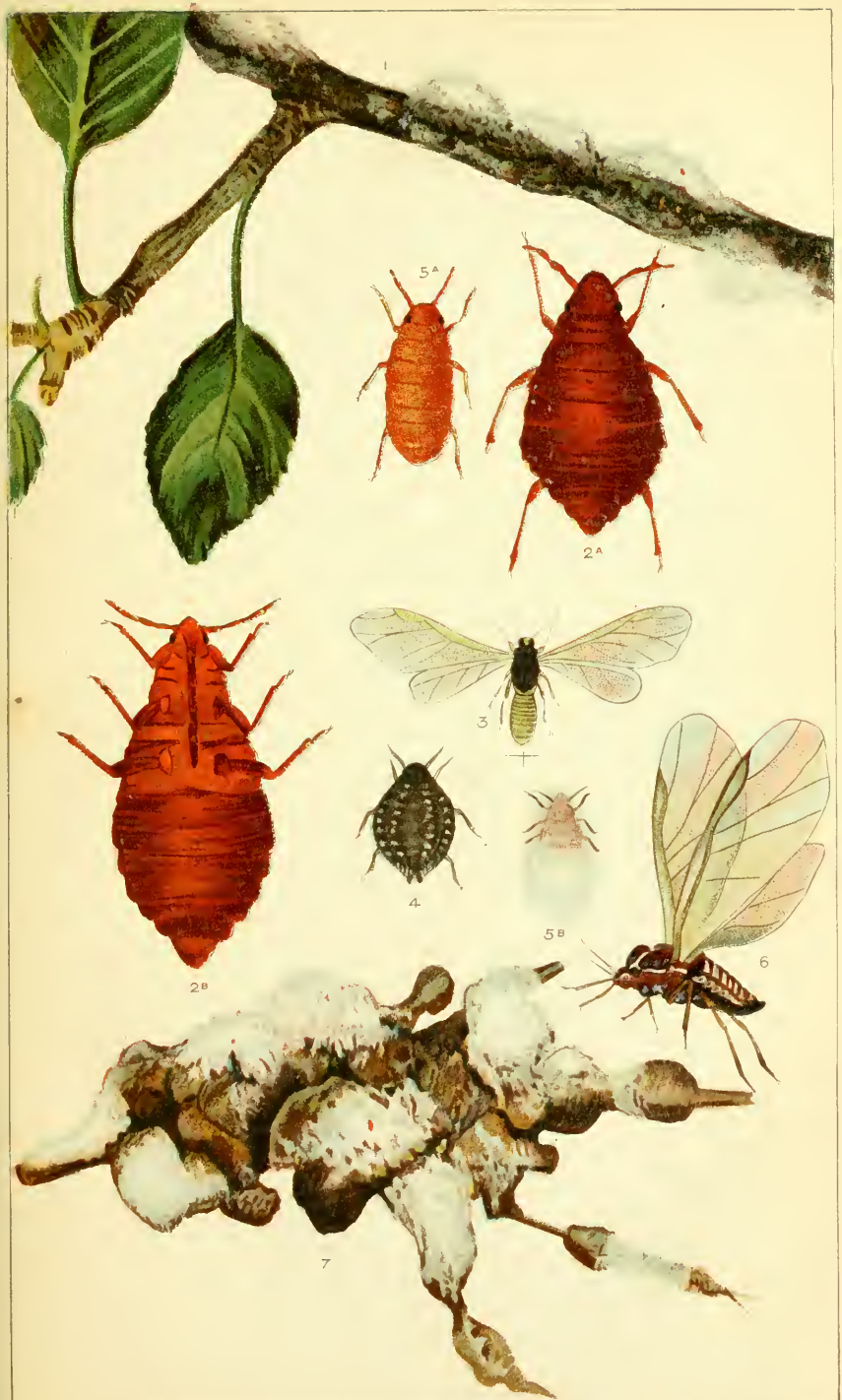
4. Queen Aphis, or foundress of the colony. Highly magnified. (After Buckton.)

5A. Young insect. Highly magnified. (From nature.)

5B. Young insect, with downy covering. Highly magnified. (From nature.)

6. Winged viviparous female. Highly magnified. (After Buckton.)

7. Roots of apples, showing downy covering to insects. (From nature.)



C.C. Brattebiard del. Sumner & M. Wright Lith. Corp.

Plate I

CHAPTER VI.

THE WOOLLY APHIS, OR AMERICAN BLIGHT.

Schizoneura lanigera. (*Hausmann.*)

Order: *Hemiptera.*
Sub-Order: *Homoptera.* } Family: *Aphidæ.*

This pest, which is supposed to be an introduction from either Europe or America, has been known to Victorian fruit-growers and gardeners for 40 years or more, and, in the early days of the colony, was considered to be little short of a scourge. In the opinion of some writers, it is supposed that the woolly blight affecting the roots of the apple is a distinct species from that which attacks that portion of the tree above ground, but from long experience I fancy that those in Victoria who are accustomed to the cultivation of apple trees, either in the nursery or orchard, hold a different opinion.

Before the advent of those excellent blight-proof stocks, the "Majetin" and "Northern Spy," it was exceedingly difficult to find, in most orchards, an apple tree that was clean or in perfect health; now, with a little care and attention, the fruit-grower, as a rule, may snap his fingers at the "American Blight," as, even if it should appear, it can now be kept within reasonable bounds, if not stamped out altogether.

But, although the blight-proof stocks have answered so admirably, it must not be supposed that the "American Blight" will not appear on the stems and branches of the trees; it is on the roots where the value of the non-blighting stocks is seen; for, even if an apple which is subject to the "woolly blight" be grafted on one of these

stocks below ground, it is perfectly safe, so far as the roots are concerned; so that, with ordinary attention to cultivation and cleanliness, the grower of apples has little to fear from this pest at any rate. The earliest records which I can obtain regarding the advent of the "Woolly Aphis" into Victoria has been supplied to me by my old friend Mr. Adcock, the well-known Geelong nurseryman, who informs me that the "American Blight or Woolly Aphis" was first observed by him on apple trees imported from Tasmania to Geelong in 1849. Mr. T. C. Cole observed it, however, in 1846, and I am not aware of it having been seen earlier than the above dates.

The introduction of *Schizoneura lanigera* into England has, it is said, been traced to the year 1789, at which period it seems to have been brought from America to an old nursery in Sloane Lane. How long it is since this pest was introduced into New South Wales and Tasmania I am not aware. According to the late Mr. Treen, the first systematic experiments with the non-blighting stock, the "Majetin," were carried out by Messrs. T. Lang and Co., the well-known nurserymen of Melbourne and Ballarat, in 1868–70, their attention having been drawn to this apple in 1862, and to the descriptions thereof given by Geo. Lindley in his "Guide to the Orchard." Lindley says that, at the time of the publication of his book, 40 years ago, it was noticed that an old apple tree growing at Norwich in England, which had been grafted three feet high, had been attacked by the "*Aphis lanigera*" or "American Blight," below the grafted part, but never above it; the limbs and branches continuing perfectly free, although all the other trees in the same garden were infested, more or less, with this blight. The variety was a Norfolk apple named the "Winter Majetin," and the Messrs. Lang and Co. concluded that, if this variety was so very free from blight as described, it should form a valuable stock for the apple, and they accordingly procured some trees from England, and such I understand, and have no reason for doubting, is the history of the introduction of blight-resisting stocks into Victoria.

The variety called the "Northern Spy" was raised in America, and was also introduced here by Messrs. Thos. Lang and Co. It is said to be superior in every way to the "Majetin," and but little else is now used on which to work young trees of the apple. Another variety, said to be superior even to the "Northern Spy," has been raised by Mr. J. C. Cole, whose father, the late T. C. Cole (the pioneer fruit-grower of Victoria), has always been to the front in matters pertaining to high-class fruit culture. The name of the new blight-resisting stock is "Perfection Paradise."

Some of the advantages which the "Northern Spy" possess over that of the "Majetin" are that it is much hardier in its nature, and its roots are not nearly so easily damaged in lifting as in the former variety. Doubtless there are some persons who would like to know the reason of the non-blighting stocks being distasteful to the aphis, and, for the benefit of such, I have here given the results of the analysis as ascertained by the late Mr. W. Johnson, Government Analyst, being a reply to a letter forwarded to him on the subject by the late Mr. Treen. Mr. Johnson says:—"I have made an examination of the young apple trees sent by yourself, the one being a crab-apple, and much infected with a species of white woolly blight; the second one, the Majetin, being quite free from blight. Both were digested in water, and the infusion concentrated by evaporation. The total amount of extractive matter was as follows:—From 2½-oz. weight of dried plants each—No. 1, Crab, 86·7 grains; No. 2, Majetin, 108 grains. The "Majetin" was more astringent to the palate than the "Crab," but otherwise very similar. The residues left after exhaustion with water were then ignited, in order to ascertain the nature of the ash left. Weight of ash—Crab, 33·3 grains; Majetin, 33 grains. The total amount of ash was therefore nearly the same. Upon being analyzed the following results were obtained:—

	Crab.	Majetin.
Carbonate of lime	7·5	16·3
Alumina and iron, soluble in weak hydrochloric acid ...	6·1	4
Siliceous and clayey matters, insoluble in acid	16·6	9·6
Other earthy matters and loss	3·1	3·1

These results show that the Majetin apple tree, which is free from blight, is a much larger consumer of lime, and it is most probably to the presence of this substance that such immunity from blight is due. The Crab, on the contrary, seems to have absorbed a much greater quantity of clayey matters, which have not been able to protect it from the attack of these insects. The total amount of ashes in each case was remarkably close. The result of the analyses seems to show the importance of a limey soil for apples; but in this matter I hardly feel competent to pass an opinion, as the experiences of fruit-growers necessarily vary very much. Still the matter is worthy of consideration, as in a comparatively new country, where apples, as well as other trees, are often planted without due consideration for either soils or drainage, and, when the failures come, all is attributed to the attacks of blights of various kinds, and little or nothing to neglect, and the want of a little circumspection when choosing the site and preparing the land for the purpose of an orchard.

A few words as to the life-history of the "Woolly Aphis" will, I trust, be useful, and this embodies the experience of many writers, both scientific and practical, in addition to my own long experience as an horticulturist in this colony.

The "Woolly Aphis," then, may be described as an insect living in hollows and in crevices on the roots, trunk, and limbs of the apple tree. They live in numerous communities, and produce, by the pricking of their beak-like rostrum, the very unsightly swellings or excrescences so well-known to orchardists here and elsewhere, and by this means absorb the juices of the tree, which, if not attended to in time, will lose its vigour, and often die.

Buckton says that the generations from the Queen Aphis vary very much, both in form and size, from their parents. They are of various shades of red or brown, and are less flattened, and longer in the body. When first born they have a most disproportionally long and

stout rostrum, or beak, protruding beyond the tail. This organ soon ceases to grow, whilst the rest of the insect rapidly develops. The insects, when adult, exude from their pores long silky threads, which curve round a centre, and often form long spiral filaments, under which they hide.

The Queen Aphis, or foundress of the colony (see Plate I., Fig. 4), must produce an enormous number of insects; but, when it is considered that the celebrated naturalist Reaumur states that an insect in five generations may be the progenitor of 5,904,900,000 descendants, and it is supposed that in the course of twelve months there may be no less than ten generations, thus exceeding in fecundity that of any other known animal, the difficulty of destroying and of keeping an orchard clean of such an insect becomes a very serious matter, at any rate to those whose trees are not worked on blight-resisting stocks.

The most common form, Mr. Crawford tells us, is that of the wingless female (see Plate I., Fig. 6), and this, as also the other figures, will be easily understood by referring to "Explanation of Plates."

Prevention and Remedies.

When the roots of the trees are badly affected, the soil should be removed from the surface, and either sprayed with a strong kerosene emulsion, or, what would be perhaps better, the application of kerosene in some form of heated vapour, as this, I have lately observed, is of a far more penetrating nature, and seems to be quite harmless to the trees. The application of gas-lime to the roots and soil has also been highly spoken of, and Mr. Tryon, in his excellent book on the insect and fungous pests of Queensland, gives the following directions for its use, as taken rom the *Gardeners' Chronicle* for 19th June, 1886:— Spread about one shovelful or more, according to the size of the tree, in a dry state within a radius of 5 feet

over the surface. The gas-lime, being a caustic substance, should not be placed immediately around the trunk, especially if the trees under treatment are young, and to kill the Aphides that may therefore remain at the root-crown, and also to prevent others from working downwards from above, fresh ashes are to be piled in this situation. In England it is the custom to trust the rain to wash the lime into the soil. When applied to a given spot it is said to retain its effectiveness for three years, but its powers are doubtless diminished if it is exposed to air and rain.

The Minister of Lands, New Zealand, has officially recommended the following effectual method of treatment in dealing with the occurrence of the "Woolly Aphis" on the roots:—Four pounds of sublimed sulphur in an iron pot, with enough water to stir conveniently while boiling for twenty minutes; then add 1 lb. of caustic potash, previously dissolved, and, whilst still hot, add as much colza, or other vegetable oil, as will make it into a thick paint. Then, when warm, with a large paint-brush daub it for the space of a foot round the butt of the stem of the tree. Rain will wash it into the roots, and the oil will tend to preserve its strength for years.

Where young trees have to be planted, and there is any reason to believe that the plants are infested, it is a very good plan to immerse the bundles of trees in tobacco-water, to which a little soft soap may be added—this is an old but very necessary precaution, and, by personal experience, its success can be vouched for. The trees may remain in the solution for twelve hours, and, if necessary, can be planted immediately. The old remedy of painting the trees with kerosene and grease (the emulsion of kerosene would be preferable) is a good one, and, if a strong brush is used, very few living insects will remain after the operation has been performed.

Mr. Koebele states that he has always had success in destroying "Woolly Aphis" when it occurs, both above ground and on the roots of apple trees, by the use of the "Resin Compound." For work above ground he sprays

a fluid containing one part of the compound to 8 of water; but he appears to recommend a stronger solution —viz., 1 to 6—for contending with the pest when it affects the roots. To mix the "Resin Compound," take 3 lbs. of caustic soda and 4 lbs. of resin, dissolve in 3 pints of water over fire; when properly dissolved, add water slowly while boiling to make 36 pints. One part of the compound to 4 parts of water, or a mixture no stronger than such as contains 3 parts of the compound to 8 parts of water, would in all probability be found to be effective as a fluid for use with the spray.

These are the best known remedies, and, if properly applied, seldom fail. In kerosene we have a powerful auxiliary in enabling us to keep down insect pests of most kinds.

Before treating the branches or upper part of an apple tree, thin out all superfluous wood, as by this means the spraying material can be made to go much further, and the result will be, or ought to be, much more satisfactory.

Before leaving the matter of the affected roots of the apple tree, I may be permitted to make mention of a trial, at which I was present, of the use of Peruvian Guano, applied to the roots of the tree, the surface soil having been previously bared. The effect of this test proved the thorough efficacy of the guano, and a repetition of it is, I think, worthy of further investigation.

In spraying the branches, the material may be used in a more diluted form, but, when trees are grafted on ordinary stocks, and the roots have become rotten by reason of neglect, coupled with the attacks of the "Woolly Aphis," it would be better to take them out at once and destroy them. There are many other so-called remedies against the attacks of the apple-blight, but the few here given will, it is hoped, be quite sufficient for the purpose.

Appended is a list of those varieties of apples which are not susceptible to blight. I am indebted to Mr. Geo. Neilson, the well-known curator of the Royal Horticultural

Society's Gardens, of Melbourne, for this list, which may be useful to those about to plant new orchards throughout the colony.

APPLES PROOF AGAINST ATTACK OF WOOLLY APHIS.

Autumn Tart.
American Golden Pippin.
Chastatee.
Early Richmond.
Fall Beauty.
Golden Queen.
Irish Peach.
Lord Wolseley.
Lincolnshire Halland Pippin (nearly blight-proof).
Menagere.
Magg's Seedling.
New England Pigeon.
Northern Spy (the best blight-proof stock).
Primate.
Ruby Pearmain.
Stubbart Codlin.
Striped Beaufin.
Tetofsky.
Winter Majetin.
Yarra Bank.

PLATE II.

"Codlin Moth" (Carpocapsa pomonella).

Fig.

1A. Branch of apple and fruit, showing damage done to pips, and mode of escape of caterpillar. (From nature.)

1B. Upper portion of fruit when newly formed, showing where egg of moth is deposited. (From nature.)

2. Perfect insect on wing and at rest. Slightly enlarged. (From nature.)

3. Showing caterpillar lowering itself from apple by means of a a silken-thread spun by the insect for the purpose. Life size. (From nature.)

4. Chrysalis of moth in portion of bark. Life size. (From nature.)

5. Caterpillar, preparing for change into the chrysalis stage. Life size. (From nature.)

6. Upper portion of caterpillar, showing mandibles, &c. Magnified. (From nature.)

7. Under portion of caterpillar, showing mandibles, &c. Magnified. (From nature.)

















Britton Bark Del. C. French Jun.r del. Hands W.M. Dougall Lith. & P.

Plate II.

CHAPTER VII.

THE CODLIN MOTH.

(*Carpocapsa pomonella. Linn.*)

Order: *Lepidoptera.*—Family: *Tortricidæ.*

This hitherto much dreaded pest of the orchardist is said to have made its appearance into Victoria about 35 years ago, as Mr. J. C. Cole informs me that his father had at that time a Windsor pear tree rendered next to useless from the attacks of the larvæ or grubs of this moth.

The true Codlin Moth is supposed then to have been imported from England during the comparatively early days of the colony, presumably either on fruit trees or in cases, but for our purpose it matters not which.

Many years ago I quite recollect the disputes which arose as to whether our so-called Codlin Moth was really identical with that of the old country, and many were the controversies arising therefrom.

This matter has now been fairly set at rest, as good specimens reared from both bands and fruit have been available for the purposes of comparison, the results of which have placed their identity beyond doubt. Mr. Crawford tells us that its presence was not identified in South Australia until Christmas, 1885; and Mr. Kirk writes as having seen grub-eaten apples some years previous to 1874, at which date it was first noticed in Auckland, New Zealand, the fruit having come from Tasmania, and he, Mr. Kirk, is doubtful whether the pest was introduced in the first place from California or from Tasmania, but Mr. Crawford thinks the latter surmise to be the correct one.

It is an unfortunate fact for us in Victoria, that with the vast extension of the fruit-growing industry here, this pest has increased and spread with alarming rapidity, and, as if not content with attacking apples and pears, it has

of late years turned its attention to apricots, and, in rare cases, even to plums and peaches, although I understand from Mr. Neilson and others that the damage done to the latter fruits so far is not to any great extent, at least we hope not.

With regard to the life-history of the Codlin Moth, there is a great difference of opinion as to whether there is more than one brood in the season, and, judging from recent trials and experiments made principally in America, it would seem to have been proved that there are (in America at least) two broods, viz., those hatched from the eggs which the female has deposited when the apple is just forming, and the second brood which is hatched from the apple at a much later stage, and these may be deposited on the face of the fruit although it is well known that the larvæ of the moth if taken from the bandages, say in early spring, will remain without undergoing a change until January, or even February, when, after a short interval, it changes into the cocoon and chrysalis stages, and from thence into the perfect insect, and at dusk resumes its flight; also the propagation of its species. This I have observed, but only while the moth was confined in a large glass-case, and the chances are, which I believe have yet to be verified or disproved, that the habits of the Codlin Moth, in some respects at least, change while in captivity. There is one thing certain, and that is, the moths of both sexes have been taken on the wing late in February, and as copulation takes place at this period, it would be interesting to know where the female moth deposits her eggs at this time of the year, as the apples are too far advanced for the first laying of the eggs, that is, if the fact of the first eggs having been laid in the newly-formed fruit be accepted, as is generally supposed to be the case. One thing seems to me certain, either the Codlin Moth deposits her eggs in the young apple and then (as with moths and butterflies generally) dies in a few days, or that the grubs, after eating part of one apple, ascend or descend as the case may be, and bore into other

fruit, when both the apple and the grub are at a more advanced stage, thus conveying the impression of a second brood. Mathew Cooke, in his very valuable work, states distinctly that from personal observations he knows the rule for the Sacramento Valley is three broods each year. The same hardworking and accomplished writer says that in 1881, on account of the early appearance of the first moths, they had four broods. These facts explain the exceptional importance of this insect in California.

The experiment, also, as mentioned by Mr. Oliff, seems to have proved beyond the shadow of a doubt the presence of two broods at least in New South Wales. Mr. Oliff says—"Early in December, 1889, I obtained a number of apples from Goulburn, containing fully-grown larvæ. These larvæ spun their cocoons at the side of the box in which I had placed them almost immediately, and in fifteen days the first moth made its appearance. I afterwards succeeded in obtaining fertile eggs from this moth, and in rearing some of the progeny, the earliest of which emerged from the pupa on 6th March of the present year. This observation established the fact that with us (New South Wales) the Codlin Moth is certainly double-brooded, and I am inclined to think, from the fact that the second generation of my Goulburn moths appeared as early as the month of March that we may have three broods in a year." Mr. Lang, of Harcourt, Victoria, is, however, amongst those who hold the opinion of the single brood, he having made some very useful observations bearing upon same.

Such matters, although of great importance to all who are connected with fruit-growing, can only be ascertained by a long and patient study of the insects themselves, and this often means a lot of time, which, though it would be well spent, is not always at the disposal of those who would like to undertake it, as evening and the early morning are the only (?) times when the habits of these moths can be properly observed—that is while in their natural state.

As there are a large number of growers who may never have seen the Codlin Moth in its perfect state, a brief description of it and its but too well-known larvæ may be useful.

The larva, or grub, of the Codlin Moth is of a yellowish-white colour, with a dark-brown, almost black, head. When full grown it is little more than half-an-inch in length. When young, the larva is very small, and its form barely perceptible to the naked eye without the aid of an ordinary lens. After the egg is deposited, which operation is performed by the female moth inserting its ovipositor into the young apple between the divisions of the calyx (see Plate II., Fig. 1[B]), the small grubs are hatched within a few days, when these little creatures commence to eat into the centre of the fruit, and finally attack the pips or seeds (see Plate II., Fig. 1), which causes the fruit to prematurely fall to the ground.

In a short time, a little over a month or so, the grub having eaten enough, slightly changes its colour, and assumes a pinkish hue, and after spinning a fine silken thread, descends by means of this (see Plate II., Fig. 3) to the ground, and hides itself in the loose bark or crevices in the trees; and Mathew Cooke tells us that in one case, where four hundred apple trees were dug up, the larvæ were found in great numbers in the roots of such trees as were decayed at or above the surface of the ground.

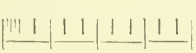
In such positions do the grubs hide themselves, and hybernate for the winter, and an enormous number of these larvæ may often be found huddled together in the folds of one small bandage, and whilst thus hybernating, it would appear that no reasonable amount of either cold or wet has any injurious effect upon them.

The presence of the grub in the apple is easily detected by the excreta which the grub has pushed from the hole by which it entered the fruit.

The tenacity of life exhibited by the grub of this moth is very striking, the writer having kept a grub, which had been dipped in a certain solution, supposed to be strong enough to destroy the Codlin Moth wholesale, for nearly

three weeks in a closely-stoppered bottle, without apparent injury to the grub. In January and February the larva spins a silky cocoon prior to changing into the chrysalid stage, having previously fastened around itself a transparent silky covering (see Plate II., Fig. 5), which can easily be seen by any one examining either the crevices in the bark or the bandages.

When the moth first emerges from the chrysalis it is of a beautiful colour, and on the hinder position of the fore-wings are two bronzy patches, with a golden margin or band to each, these particular tints being very difficult to show on a plate. The hind wings are of a light golden-brown, and the moth itself measures about half-an-inch across the wings when fully expanded.* For convenience sake the measurements are mostly given according to the French system of lines, and the accompanying engraving will explain the method of using this system, which has been also adopted by Mathew Cooke—



Specimens of the "Codlin," as well as other moths and butterflies, are always better and more perfect, both in shape and colour, if reared from the bandages obtained from the trees, or from the fruit itself, as if caught on the wing, the specimens are mostly rubbed or otherwise injured, and it has been observed that no sooner do the perfect insects emerge from the chrysalis than they very soon become lively, and pairing takes place within a few hours, the eggs being deposited shortly after, and thus if the specimens are not captured at once, they become next to useless for either comparison or for the cabinet.

Mr. W. Kershaw, one of our best observers, tells me that he has captured the moth in the middle of the day, but I have not seen this fact for myself, although I have no doubt whatever but that his statement is correct.

* The measurements of insects in this Handbook are given in inches and lines. The above cut represents one inch divided into lines and fractions thereof.

It has been stated on good authority that the grub of the Codlin Moth does not remain in the fruit after it has fallen from the tree, but this assertion is hardly borne out by facts, as I myself have reared the moths from grubs taken from the apple, the fruit having been picked up from off the ground, hence the necessity of gathering up and destroying the grub-eaten apples which have fallen.

The mode of exit of the grub from the apple is somewhat singular, and the alleged and usual declination in the shape or direction of the "tunnel" by which the larvæ escape from the fruit is not shown on our plate, the figure having been drawn from nature (see Plate II., Fig. 3), the apple having been kindly sent to me by Mr. Neilson, showing therefore that the mode of exit is not always the same, although usually the declination can be plainly seen, as mentioned by F. C. Christy, of the Field Naturalists' Club, and others.

Prevention and Remedies.

As to prevention and remedies, it will be remembered that it is but a few years ago when many orchardists were preparing to give up the growing of apples and pears, out of sheer despair, as no sooner had they, by the aid of blight-proof stocks, coupled with their own exertions, succeeded in successfully fighting the woolly-aphis and other pests, than the pear-slug, apple mussel-scale, and other accursed importations seem to come along and baffle all their best efforts to exterminate them. Little wonder, then, that these people should be apprehensive for the future of fruit-growing. Now, however, since the justly proverbial go-ahead system of our American friends has been so successfully carried out in the direction of "casting about" for remedies against pests all and sundry, we have, chiefly by their aid and investigations, become possessed of valuable remedies against the Codlin Moth and other insects, which, if properly and judiciously applied and

carried out, will go a long way towards reducing to a minimum the damage done by pests of all kinds. One of the greatest dangers with which the orchardist has to contend is the introduction, by means of fruit-cases, of many pests (the Codlin Moth included), and, as Mathew Cooke says—"All empty cases and fruit packages returned from market, or used in shipping fruit in any manner, should be thoroughly disinfected before being taken to the orchard, by dipping in boiling water, containing one pound of commercial potash to each twenty gallons of water used, the package to be left in such solution at least two minutes. If only boiling water is used, the package should be kept in it at least three minutes." A simple and cheap plan of doing this would be, I think, to attach a boiler to one of those square iron tanks used for catching rain-water, as by this means a waggon-load of boxes could be put through in a very short space of time, the after cost being simply the matter of a little fuel.

The proper time to treat for the Codlin Moth is when the fruit, be it apple or pear, is just "set," formed on the tree, and as some kinds are early and some late (districts also influence to a considerable degree the time of both flowering and fruiting), no particular month need here be mentioned. This information is given on the supposition that a first commencement is to be made during the present season after the flowering time, and immediately on the setting of the fruit. The mode of dressing the tree, as successfully carried out in America, Europe, and elsewhere, is to obtain 1 lb. of London purple, and well mix this powder with 100 to 150 gallons of water. The powder should be crushed very fine, so as to render not only the mixing easier, but to enable the liquid to pass through the fine nozzle of the spraying-machine, or pump. When the mixture is prepared and ready for use, fix the vessel containing same on a "trolly" or other conveyance, such as is shown in the engraving, and by means of a spray thoroughly saturate the whole tree. [Illustrations of the various spray-pumps, &c., are also given at the end of the book.] The object of thoroughly

saturating the tree being to cause the liquid to run down and penetrate into the hollow cavity in the young fruit, by which means the newly-hatched grub is destroyed. A second application a few weeks later would be of advantage, when there is every reason to believe that the first batch of grubs, at any rate, will be quite destroyed.

The use of London purple and Paris green (both being of a poisonous nature) has been objected to by many excellent authorities, but it has been proved, beyond all doubt, by means of carefully conducted experiments carried out in America and elsewhere, that the fruit so treated is perfectly free from even a taint of the poison; still such materials should always be used with a reasonable amount of precaution. The use of kerosene in an emulsified form is also highly recommended, and for those who wish to try it against the Codlin Moth, I may say that the American formula, as adopted by the late Mr. Crawford and others, coupled with personal observations, is as follows:—

Kerosene	1 pint	1 quart	½ gallon	2 gallons
Common hand soap	½ oz.	1 oz.	2 oz.	½ lb.
Rain water	½ pint	1 pint	1 quart	1 gallon
This will make of emulsion ...	1½ pints	3 pints	3 quarts	3 gallons
For Wash A add rain water ...	6¾ quarts	3 gallons 3 pints	6 gallons 6 quarts	27 gallons
Total quantity Wash A... ...	7½ quarts	3 gallons 3 quarts	7½ gallons	30 gallons

The above, as Mr. Crawford remarks, are the proportions to make the strongest wash recommended, being one part kerosene to fourteen parts water. To make the emulsion, if hand soap is used, cut the quantity required into thin slices, so that it should dissolve easily in the proper amount of rain water when being heated to boiling point. As soon as it is all dissolved, pour the boiling solution into a vessel containing the kerosene, and churn the mixture for five or ten minutes by means of a garden syringe or force-pump and nozzle. The emulsion, if properly made, forms a cream-like substance, which thickens on cooling, and should, if properly made, adhere without oiliness to the surface of the glass. The emulsion should not

be diluted until required for use, when hot (rain) water, if possible, should be used. In using the kerosene emulsion, the same system of spraying as that previously alluded to as being adapted for the use of London purple can be followed out; and recent experiments, by Professor Riley in America and others in Europe, have proved beyond a doubt that Paris green and London purple may be relied upon as the two best materials for spraying yet tried for the purpose, the price of the London purple being about 2s. per lb. (cheaper if purchased in bulk), and it can be obtained from any wholesale druggists in Melbourne, also from seed merchants, by whom it has been imported.

The recent trials of steam-power machines for the purpose of destroying insects, which has taken place at my suggestion, has in my opinion proved, beyond the possibility of a doubt, their superiority over machines worked by hand, and it must be but the matter of a little time which it will take to perfect these steam machines, when, if they can be constructed cheaply and with comparative safety, they are certain to be largely used in extensive orchards and vineyards where the cost of labour is so great a consideration. Further and more elaborate experiments as to the material to be forced through them will, it is hoped, add to their usefulness as the insect and fungoid destroyers of the present time. In the case of the hybernating larvæ of the Codlin Moth, &c., the application of steam in any form to the stems and crevices of fruit trees must be attended with the most favorable results, which if to be effective the work must be done at the proper time and in a thorough manner. The use of bandages around the trees, for the purpose of trapping the grubs, is also a most excellent plan, and if properly carried out, and the bandages examined in a systematic manner, an orchard, as Mr. Neilson remarks, may be kept tolerably clear of Codlin Moth, providing that no slovenly and careless neighbour be permitted to leave his trees untouched and unattended to, in which case the careful grower is placed at a serious disadvantage, by having to put up with a regular nursery of insect pests at

his very door without being able to help himself—a proceeding which is manifestly unfair to those who spend both their time and means in an uphill attempt to keep their orchards in a proper state of cleanliness.

As showing the advantage to be gained by the use of bandages, Mr. Oliff, Entomologist to the Department of Agriculture of New South Wales, in quoting from Mr. Howard, tells us that "two bands should be applied to each tree, one above the other, and Dr. Le Baron has shown that in a five-tree experiment, the bands being from 1½ feet to 2 feet above the other, that the number of grubs found in the upper bands was 282, and in the lower ones 350, and in nearly every case the lower ones contained the most;" but to be effective, as has often been remarked, growers must unite. The simplest and best bands are perhaps those made from old (not rotten) bagging cut into strips of, say, 4 or 5 inches in width. These bands should be carefully removed, and the grubs destroyed at least every week or ten days—that is during time of hybernation. Scraping off the loose bark with a three-cornered piece of iron, fastened on to a handle (an altered ship's scraper will do), is another good plan, as by this means the shedding bark is removed and the places of concealment for the grubs considerably lessened. In treating fruit trees either for insects or fungi too much care cannot be taken that suitable weather is chosen for the purpose, as, if it is wet, the fluid is washed off the tree before it has done its work, and on the other hand, if the sun be powerful, there is a probability of the foliage, buds, and even the fruit itself, being either burned or scalded. The proper time to treat fruit trees generally is on dull (not wet) days, and, as has often been proved, two applications with a weak solution (so long as too much time is not allowed to lapse between the two operations) is better and is likely to be more effective than one dressing with a solution which may at once be too strong. This sort of work is to be learned only by practical experience and not by the guidance of theory, as is too often the case in newer countries.

Before leaving the subject of the Codlin Moth, it may be mentioned that in Victoria we have not as yet had much experience of any parasites on the larvæ of this moth. Mr. P. Anderson, of Horsham, a gentleman who has taken an interest in such matters, assures me that "he has seen a rather long wedge-shaped fly following the moth whilst in the act of depositing its eggs in the 'blossom' of the apple." It would be difficult, without having seen a specimen, to form any idea of what this particular parasite may be; but possibly it belongs to one of the Hymenoptera, either Ichneumonida or Braconidæ, or it may be a dipterous, or two-winged, fly. This matter, with Mr. Anderson's assistance, I hope to clear up during the coming spring. In the valuable papers on noxious insects by Mr. Oliff, of the Agricultural Department of New South Wales, a figure is given of some American hymenopterous parasites of the Codlin Moth. I must confess, however, that I am not inclined to pin too much faith to waiting for the extermination of insect pests generally through the agency of parasites, relying more upon united energy and the use of the various solutions recommended for their destruction.

That an orchard may be kept comparatively clean of Codlin Moth there can be no doubt, this much having been proved by growers in America and elsewhere, and with us there must be "no such word as fail."

PLATE III.

"CURVE-WINGED APPLE MOTH" (ERECHTHIAS MYSTACINELLA).

Fig.

1. Branch of apple, showing excrescences caused by "Woolly Aphis," and projecting pupæ-cases of moth, also moths at rest, and caterpillars in wood. Natural size. (From nature.)
2. Moths on wing. Natural size. (From nature.)
3. Moth on wing. Magnified. (From nature.)
4. Larvæ (or caterpillar). Magnified. (From nature.)



C. Brittlebank. del. C. French. Direxit. Troedel & Cº Lith

Plate III

CHAPTER VIII.

THE CURVE-WINGED APPLE MOTH.

(*Erechthias mystacinella.*)

Order: *Lepidoptera.*—Family: *Tineiniæ.*

A small insect to which (owing to the singular curvature of the wings) I have given the common name of the "Curve-winged Apple Moth."

This little pest is but imperfectly known, and I am indebted to Dr. T. P. Lucas, of Brisbane, the well-known lepidopterist, for its name; and as I had not the necessary specimens for comparison, he has kindly compared and identified the specimens for me. Mr. Anderson, of the Field Naturalists' Club, who has brought this, one of the least known of apple pests, under my notice, says that unnamed specimens of this moth have been in the University Museum for some time, and it plays no unimportant part in the destruction of apple trees throughout the colony.

The female deposits her eggs among the loose bark, or in any crevice in the stem or thick branches of the tree, being especially fond of the warty excrescences caused by the *Schizoneura*, or "Woolly Aphis"—blight of the apple, but which probably is aggravated by the gnawing and tunnelling of the larvæ of this species. (See Plate III., Fig. 1.)

As this moth is very abundant, its depredations are often on a serious scale, the number of bores and tunnels and the admission of air and moisture generally weakening the vitality of the tree, which frequently is brought to such a low state of health that a little extra pressure, even by the wind, will cause the limb to snap off, and in any case the sap is interrupted from its natural flow, which instead of being utilized in a natural manner wastes itself in the enlargement of the unsightly excrescences as mentioned, and also shown in the plate.

Mr. Anderson is of opinion that there are three or four broods of this moth during the year, so that when once a lodgment is made, this little pest effects considerable progress; and he (Mr. Anderson) has observed the most abundant brood to be that which emerges during October from larvæ which have been feeding throughout the winter months. The moth seems to be a truly indigenous species, although little is, so far, known of its former habits, and it may have adapted itself to the apple in a similar manner to that of the well-known cottony cushion scale, *Icerya Purchasi*, which latter insect was known thirty years ago to feed on the common wattle, as it also does at the present time.

The supposed natural and original habitat of this species is the acacias or wattles, and many of the spongy-looking galls by which these trees are disfigured are supposed by Mr. Anderson to be caused by these moths.

The perfect insect is about half-an-inch across the upper wings, or perhaps a little less. (See Plate III., Fig. 2.)

The larvæ are small, of a greenish colour, and are also shown (see Plate III., Fig. 1) in their natural size.

This being somewhat of an unknown enemy to apples, it behoves growers to be on the alert, and commence operations against it at once. The cutting down of old and decayed wattles growing near an orchard is absolutely necessary, these trees being more susceptible to insect pests than any other of our native timbers; and as it has been proved that indigenous insects will adapt themselves to introduced fruits, it is apparent that every reasonable precaution should be taken to prevent their spreading to orchards in the vicinity.

Prevention and Remedies.

As a remedy, I would suggest the constant use of the spray-pump, and, as I have previously remarked, the larvæ and pupæ of this insect being mostly found in the old workings of the Woolly Aphis, as shown in the plate, it would be likely that by treating for the above aphis the eggs and larvæ of the moth would be destroyed at the same time.

Kerosene emulsion in any form ought to prove an effective remedy against the "Curve-winged Apple Moth," and if carefully watched for a little time, growers, I think, have little cause to apprehend much danger from this comparatively new apple pest.

When an apple tree has been badly attacked (root and branch) by the Woolly Aphis, it will generally be in such a weak state as to render it all the more susceptible to blights, both insect and fungous, so that trees which are past redemption should be at once grubbed out and burned, and the holes before replanting should be thoroughly treated with lime, and trees of a different nature planted in the place of those dug up. For thoroughly disinfecting the ground of this kind, the bisulphide of carbon as also "Quibell's Tar Extract" will, if properly applied, be found to be cheap and effective remedies.

This insect has been figured by Mr. Anderson, to whom I am indebted for the specimens from which our drawings have been taken.

PLATE IV.

"Apple-borer Beetle" (Rhizopertha collaris).

Fig.

1. Section of stem of apple tree, showing Borer-beetle on outside. Natural size. (From nature.)
2. Section of stem split open, showing larvæ, and perfect insects at work. Natural size. (From nature.)
3. Perfect insects. Natural size. (From nature.)
4. Perfect insect. Magnified. (From nature.)

4a. Perfect insects. Magnified. (From nature.)



C.Brittlebank del C.French.Direxit. Troedel & Co Lith.

Plate IV

CHAPTER IX.

THE APPLE-TREE BORER BEETLE.

(*Rhizopertha collaris.*)

Order: *Coleoptera.*—Family: *Bostrychidæ.*

A small but most destructive beetle, the Australian type of which, B. jesuitus, is but too well known in Queensland as a ruthless destroyer of timber of all kinds, and in which colony it is known by the name of the "telegraph-pole borer," very few of the indigenous or even imported timbers being sufficiently hard to resist its attacks.

This little pest of the apple tree was first described by Erichson, in 1842, as coming from Tasmania, and from whence I have received specimens found always in the native timbers, and not in fruit trees, and it has been sent from nearly all the Australian colonies, thus showing its very wide distribution.

Apate dorsalis, a somewhat similar looking beetle, according to Professor MacOwan, of Cape Town, does great damage to the Mimosa gum trees of South Africa, often rendering this otherwise valuable gum perfectly useless for commercial purposes.

This curious little beetle, whose depredations amongst apple trees have been now well ascertained, is about from two to three lines in length, with a singularly shaped prothorax, at times nearly hiding the head of the insect. (See Plate IV., Fig. 3.)

This species was first brought under my notice by Mr. Geo. Neilson, the well-known Curator of the Royal Horticultural Society's Gardens, who received it from the neighbourhood of Sydney. Shortly after other specimens reached me from the Brandy Creek district of South Gippsland, during the month of December, 1889; and there is good reason for believing that its ravages are by

no means confined to these two portions of the colonies. The apple trees are attacked by boring into both stem and thick branches, the damage being done by the insect boring small holes into the wood, in which the egg is deposited, the larvæ (or grubs) at once commencing to eat in an horizontal direction (see Plate IV., Fig. 1, which explains the matter better than any description could do) right into the wood of the tree, which, if undetected, soon cause the trees to wither and die, the grubs and the perfect insect remaining in the tree for some time after the tree has ceased to live.

Prevention and Remedies.

As soon as the damage done is observed, the tree, if very badly bored, should be at once cut, or grubbed out and destroyed by burning, especial care being taken that none of the larvæ (which are small white grubs) escape. The next best thing to be done is to apply a strong solution of kerosene emulsion, say 1 in 12 or 14, by means of a good spray-pump; but, as the holes are placed horizontally, the liquid must be used with considerable force, so that it may be driven horizontally as far as possible into the holes, when not only will the grubs and beetles be destroyed but the bark will be rendered, for a time at least, obnoxious to the beetle, and would, in all probability, be the means of preventing the insects depositing their eggs or otherwise working on or in the bark of the tree. Remove, by scraping, all loose bark. As in the case of the Codlin Moth, the less shelter afforded to insects the less will be the danger of their attacks, and the easier it will be to detect any inroads of borers, &c., and to treat the trees for same. As this is another instance of an indigenous insect adapting itself to imported fruit trees, it behoves fruit-growers to pay special attention to the immediate destruction of all badly infested native timber, as the latter may prove to be a practically unlimited source of trouble to those whose orchards happen to be in the vicinity of forests or timbered country in general. In

very few cases, however, will it be found necessary to chop out any infected fruit tree, the practice of so doing being an unnecessary one.

The application of tar mixed with grease, as also white lead and raw oil, has been recommended for use against borers, by smearing or painting the trees; and although I have used both successfully against certain boring insects, I should hardly care to advocate its general use, more especially on fruit trees, but should prefer keeping a sharp look out for signs, which are too well known to the practical fruit-grower, and at once tackle the borer by the various means already indicated.

Stopping the holes with wire has been suggested, but owing to the high price of labour here its use in large orchards would be next to impossible.

The application of sulphur, tar, bisulphide of carbon, or other fumes, by means of steam-power (providing the machine can be produced at a price within the reach of at least the large growers, and with some modification of detail), would, in my opinion, be perhaps the most effective of all methods, as the forcing of the steam would penetrate so far into the workings of the insects as to either make their position altogether untenable or entirely destroy them, grubs and all, to say nothing of its usefulness in distributing the Bordeaux mixture, and other fungus-resisting compounds, to the resting spores of fungi, as Fusicladium (or scab), Capnodium (or smut fungus), Roestelia (or scab), Mildew, Oidium, curl in peach, shot-hole of the apricot, black spot on grapes, and other pests of the orchardist and vigneron.

The habits of Scolytus destructor, or elm-beetle of Europe, are somewhat similar to those of the "apple-tree borer;" the principal economic differences being that the workings of the "elm-borer" assume the shape of irregular tunnels or burrows; the insect, however, being quite as difficult of eradication as the "apple-tree borer." Whole avenues of magnificent elms in France and elsewhere having had to be cut down and destroyed owing to the attacks of these Scolytids.

In the south of Europe, Kirby tells us that one of this latter group, Phlæotribus Oleæ, is very destructive to the olive.

Orchardists and foresters, then, would do well to keep a sharp look-out for the two latter mentioned insects, which may be introduced at any time, and by various means. Such discoveries should at once be reported and immediate steps taken to arrest the progress of the invader.

PLATE V.

"Light-Brown Apple Moth" (Cacæcia responsina).

Fig.

1. Apple branch and fruit, showing damage done to pips, with larvæ escaping. Natural size. (From nature.)
2. Moths on wing. Natural size. (From nature.)
3. Upper portion of apple when newly formed, showing where eggs of of moth are deposited. (From nature.)
4. Larvæ (or grub). Magnified. (From nature.)



Plate V.

CHAPTER X.

THE LIGHT-BROWN APPLE MOTH.

(*Cacaecia responsana.*)

Order : *Lepidoptera.* Family : *Tortricidæ.*

This insect, which is known to growers by the name of the Australian Apple Moth, is a pest of the very worst kind, and in many cases its ravages have been of a most serious nature.

In appearance it is totally unlike the true Codlin Moth, although as so little has hitherto been known here of the perfect insects of either, it has in many cases been taken for the imported Codlin Moth, *Carpocapsa pomonella.*

The habits of this insect are very similar to those of the true Codlin Moth, inasmuch as the eggs are deposited in the calyx of the young apple; the larvæ however, as a rule, do not always penetrate so far as the pips, and owing to this circumstance the grub will sometimes remain a long time within the ripening fruit, the mode of attack being shown in Plate V., Fig. 1. The larva or grub is of dirty light-green colour, the perfect insect being light-brown, with slightly barred wings, which are about three-quarters of an inch across, that is in good female specimens; and the illustration (see Plate V., Fig. 4), which has been drawn from nature, will explain all without a lengthy description being necessary.

Mr. Oliff speaks of another species, *C. postvittana*, of this genus of moths as being very injurious to apples; but the insect from which our plates have been taken is certainly not the above one, although I believe the larger species, *C. postvittana*, to be here also, but to what extent the damage done by it has, I believe, not yet been perfectly ascertained.

The late Mr. Frazer Crawford, in his excellent work on "Insect and Fungous Pests attacking Pear Trees in South

Australia," describes a moth also under the common name of the light-brown moth; but from his description of the habits of this insect, it is quite evident that it is not in any way related to the one which we have just described, viz., *C. responsana*. Let us hope that the light-brown moth of South Australia will not visit our already pest-stricken colony.

Dr. Lucas has in this instance also been good enough to compare my insect with his specimens of the same moth, and has kindly furnished the name.

This species is supposed to have made its appearance from some of our native trees, and, so far as I am aware, is principally confined to the apple.

Prevention and Remedies.

When the fruit is just setting, spray twice, or even thrice, with a solution of either London purple or Paris green, say 1 lb. of the former to 100 or 150 gallons of water. Apply material with considerable force, so that it may the easier penetrate into the hollows in the young fruit. As the habits of this insect so nearly resemble those of the Codlin Moth, the system of bandaging the trees, gathering up the fruits, and other methods previously recommended, should also be adopted for this pest.

PLATE VI.

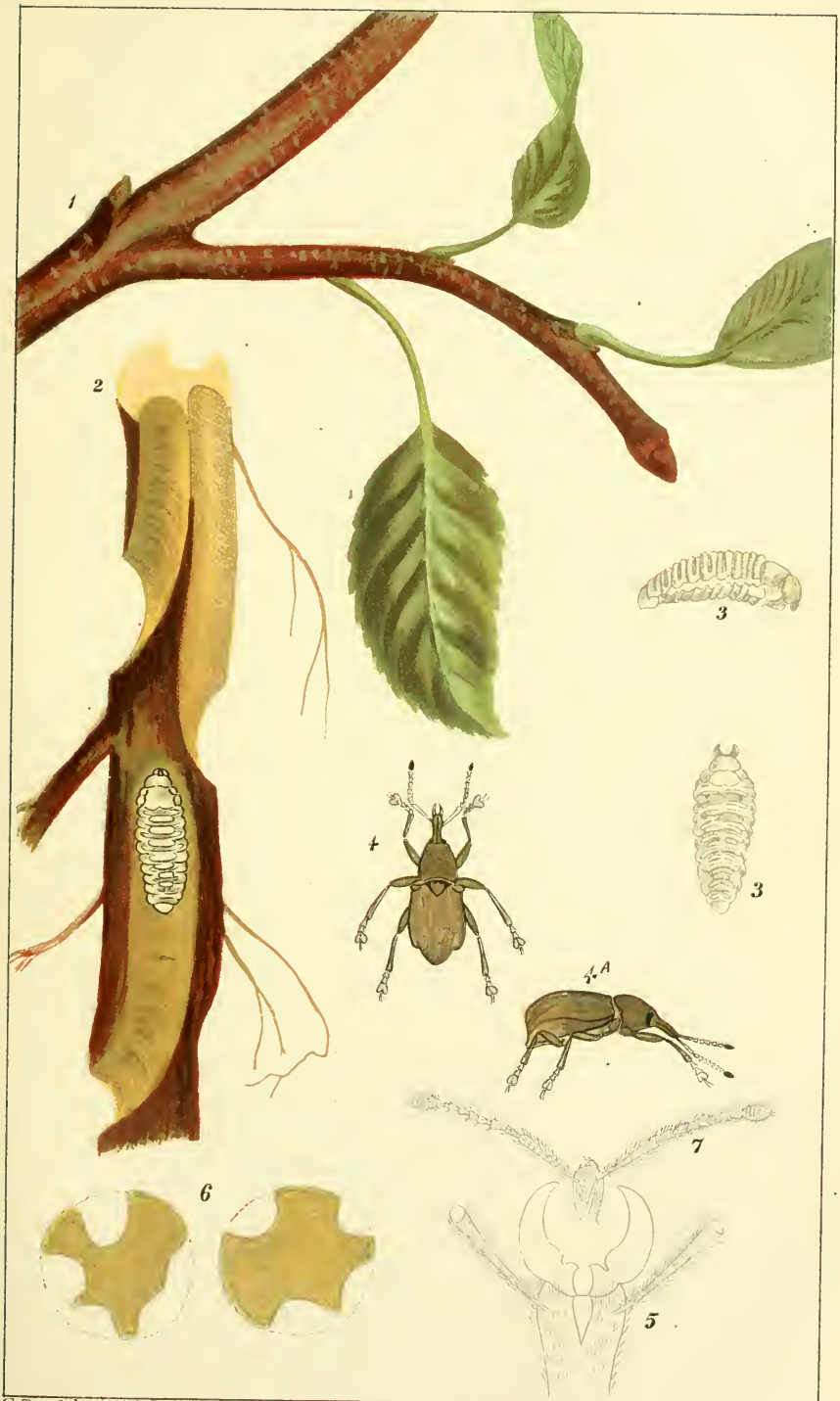
"Apple-root Borer" (Leptops Hopei).

Fig.

1. Portion of apple stem. (From nature.)
2. Portion of root, showing larvæ at work. (From nature.)
3. Larvæ (or grub). Natural size. (From nature.)
4. Perfect insect. Natural size. (From nature.)

4a. Perfect insect; side view. Natural size. (From nature.)

5. Showing singular mandible-like process. Magnified. (From nature.)
6. Transverse sections of roots. Natural size. (From nature.)
7. Antennæ of perfect insect, showing joints. Magnified. (From nature.)



C. Brittlebank. del. C. French. Direxit. Troedel & Co Lith.

Plate VI

CHAPTER XI.

THE APPLE-ROOT BORER.

(*Leptops Hopei.*)

Order: *Coleoptera.*—Family: *Curculionidæ.*

A very destructive beetle, belonging to the great group of the *Curculionidæ*, of which there are in Australia over 1,200 different kinds, which have been already described in various publications. This group of beetles is but too well-known as furnishing some of the worst of insect pests to the grower—the Rice-Weevil, Pea-Weevil, Nut-Weevil, Plum-Curculio, Bean-Weevil, and a host of other kinds commonly known by the name of "Weevils."

This insect is indigenous to Australia, no less than 44 species of this genus having been found in the various colonies. In Victoria this particular species of *Leptops* has been known for the last 30 years to attack fruit trees, especially apples and pears, but it was not until a few years back that it was found to be such a dreadful scourge to fruit-growers.

The perfect insect (as shown in Plate VI., Fig. 4) is of a light-greyish brown colour, about an inch in length when its fore-legs are stretched out. The singular mandible-like process (see Plate VI., Fig. 5) which the Rev. Mr. Blackburn, of Adelaide, informs me had been already noticed and referred to, I think, by Boisduval, the celebrated French naturalist and voyager, is seldom seen in such a marked manner as in the case of the beetle from which our plate is taken.

The larva is a yellowish-white clumsy-looking grub, about an inch in length (see Plate VI., Fig. 3), which attacks the trees by tunnelling into its roots (see Plate VI., Fig. 2), the consequence being that the very foundation of the tree is sapped, and the indications of its decay

first perceived on the tops of the branches, the supposition being that the eggs are deposited near the stem of the tree, and just below the surface of the soil.

This beetle being a native it has unfortunately a very wide range, its natural food being wattles, gums, &c., and on these trees it is often to be found in large numbers. A few years since Mr. H. King, the well-known fruit-grower and present lessee of the Fairview Gardens, Fyansford, near Geelong, observed large numbers of his apple and pear trees to be dying off from the top branches downwards, and was quite puzzled to make out the cause. Upon further consideration, however, it struck him that the roots of the trees must have been attacked by some kind of grub or borer. Digging down to the roots of the tree, he discovered that the larger roots (few, if any, nearer to the surface than 8 inches) had been tunnelled by an insect. Specimens of the grub were secured and forwarded to me, but, in the absence of the perfect insect, I was unable to do more than to hazard an opinion as to the group to which the insect belonged. Some time after this, Mr. King wrote, inviting me to his orchard, as I was anxious to see the grub at work, also if possible to find the perfect insect. Mr. King, with the assistance of his men, very soon rooted up several good-sized apple trees, the final result being that both grubs and specimens of the perfect insect were taken from below the surface of the soil. Others in the perfect stage were taken on the branches of some small peach trees, and thus we are quite positive as to the identity of the insect.

Mr. Crawford describes another kind of Curculio of the same genus, which in South Australia attacks apple-roots in precisely the same manner; but the latter species, *Leptops robusta*, has not, so far as I am aware, been found in this colony.

The facts which have lately been brought under our notice regarding the native insects leaving their natural food, and adapting themselves to introduced fruits, should cause us to seriously consider whether the assistance of the Conservator of Forests should not be invited, for the

purpose of co-operating with the growers in the event of any serious inroads of native insects taking place—that is, where forests or public reserves are in close proximity to either farms, orchards, or vineyards. This could be accomplished by destroying any native tree which was found to be particularly badly infested with insects of any kind, as well in the interests of the timber and wattle-bark industry as for the farmers and fruit-growers themselves.

As showing the damage done to apple and pear trees by this Curculio beetle, I may cite one instance only, as supplied to me by Mr. King, where he says that in the years 1868–78 he had to root up and destroy 13 acres of fine trees, most of which had been in full bearing. It would be well, then, now that an Entomological Branch has been established, to at once report the appearance of any strange insect, so that advice might be obtained as to the best means to be adopted in promptly dealing with it.

Prevention and Remedies.

When a tree is attacked by the grub of this beetle, the fact will be discovered by the branches dying off from the top downwards. Procure a crowbar, make, say half-a-dozen holes to the depth of from six to twelve inches (not too close, however, to the stem of the tree), into which pour a small wineglassful (to a large tree) of pure bi-sulphide of carbon; cover the hole as tightly as possible to prevent the escape of the fumes, and by these means it is hoped that the grubs, as well as any eggs or perfect insects, will be almost instantly killed. Quibell's tar compound, which Mr. Knight, the Government Fruit Expert, tested at my request, it is also expected, will have a good effect in destroying the insect without injury to the tree, and can with confidence be recommended for the purpose.

Painting the larger roots with a weak solution of corrosive sublimate would, in my opinion, be well worthy of a trial, as I feel convinced, from past experience of its use as a preservative for natural history specimens, that no insect

could or would attack the tree for, at least, some considerable time. It having been observed that the small and fibrous roots are not often attacked, the lifting of the trees and the removal of many of the larger roots before again re-planting has been tried, and, fortunately for growers of apples and pears, the results have, so far, proved successful, it having been ascertained (so Mr. King informs me) that the trees have thriven and borne well after this seemingly heroic treatment.

It is a matter of great regret that this formidable pest should have made such headway, and is so widely distributed throughout the fruit-growing districts of the colony, and it is to be hoped that, in addition to the preventive and remedial measures already suggested, growers will co-operate with the Entomologist, Mycologist, and inspectors, with a view of stamping out all plant enemies, whether insect or fungoid.

It should be observed that the more vigorous the growth of any plant, and the freer it is kept from rubbish and litter of all kind, the less liable is it to be attacked by insect pests of any kind. Where small native trees abound near orchards, a search should be made on the leaves for this Curculio, when they can be shaken off and destroyed, and their numbers greatly lessened.

Bi-sulphide of carbon can be obtained in bulk, or in small quantities, at about 5s. per gallon, and being highly combustive, care should be taken to see that it is kept tightly corked and away from intense artificial heat. Carbon fumes, if inhaled, have the reputation of being very injurious if used in close or confined places (although, having used it for years, I have not found it so).

Quibell's mixture can be purchased either in bulk or in small quantities from McLean Bros. & Rigg (cost, pure, about 6s. per gallon), which will make from 20 to 30 gallons of the liquid ready for use. There are, doubtless, many other remedies, but only those which have been tested here are at present mentioned.

PLATE VII.

"Apple-bark Scale" (Mytilaspis pomorum).

Fig.

1. Stem of apple showing scale insects on same. Natural size. (From nature.)
2. Puparium of adult female, overturned, showing enclosed female. Highly magnified. (After Miss Ormerod.)
3. Puparium of adult female, also showing eggs. Highly magnified. (After Miss Ormerod.)
4. Puparium of adult female (upper side). Highly magnified. (After Miss Ormerod.)
5. Puparium of male. Highly magnified. (After Riley.)
6. Adult female. Highly magnified. (After Maskell.)
7. Female puparia. Much magnified. (After Maskell.)
8. Adult male (winged). Highly magnified. (After Cooke.)
9. Apple. Showing scale on surface. (From nature.)



Plate VII.

CHAPTER XII.

THE APPLE-BARK SCALE.

(*Mytilaspis pomorum.*)

Order: *Hemiptera, Section Homoptera.*—Family: *Coccidæ.*

This most formidable enemy of the apple-grower is an importation from either Europe or America, and has long been known in those parts as one of the worst pests affecting the apple.

The large family of the *Coccidæ* are, unfortunately, too well known, the life-history of most of them being very singular; and if only for the purpose of studying their habits with the view of endeavouring to find out some weak spot in their economy so as to be able to take advantage of it by preventative or remedial measures, the time so devoted would, by the knowledge gained, be amply repaid.

Mr. Maskell, whose valuable work on the "Scale Insects of New Zealand" is so well known, tells us that "the male of this species is unknown in New Zealand and Europe, and doubtful in America," so that although the Mussel-scale of the apple is a well-marked species, its resemblance to other kinds of the same germs feeding upon certain native plants is so great, that to distinguish them would require the aid of a specialist, otherwise important mistakes in identification may happen.

Every orchardist whose apple-trees are infested with the *Mytilaspis* will have observed both stem and branches, and often the fruit also, to be covered with a small mussel-shaped Scale of about one line, or less, in length (see Plate VII., Fig. 1), the cluster generally being thickened where a joint occurs in the branches; these are the female Scales, the male Scales, according to Professor Comstock and others, being much smaller. I have not yet heard of a perfect male having been found here.

Beneath the larger scale, if the edge be carefully lifted with the point of a small knife and turned upside down, it will be observed, by the aid of an ordinary pocket lens, to contain a number of minute white eggs (see Plate VII., Fig. 3), 40 or more in number, which, upon being magnified under a fairly high power appear to be composed of white transparent matter—the months of April, May, and June, being very good ones for observing this insect whilst in the egg stage.

The eggs are soon hatched, and at once these tiny creatures commence operations upon the unfortunate tree, and from thence often spreading to the fruit, doing great damage to the former by absorbing the juices of the tree, and to the latter by at least disfiguring the fruit (see Plate VII.), thereby lessening its fresh appearance and consequently its market value.

When this pest (as is the case with the majority of Scale insects) finds its way into an orchard, it will, if not at once checked, spread with fearful rapidity, and in orchards of large and old trees is then difficult to contend with.

At the recent conference of fruit-growers, held to take into consideration the advisability or otherwise of introducing a Noxious Insects Bill, one of the delegates present, Mr. Errey, jun., of Camperdown, Victoria, brought a piece of the limb of a gum-tree (one of the Eucalypti), upon which the Mussel-scale fairly swarmed. Unfortunately, the specimen was removed before I had time to compare it with those obtained from the apple-tree; but this I yet hope to do, as if it can be proved that this pest has transferred itself to our native trees, it becomes a very serious matter for us. Probably, however, it may be identical with Mr. Crawford's *Mytilaspis Eucalypti*, a species found on the gum-trees in South Australia, but distinct from that attacking apples.

Prevention and Remedies.

When once apple trees are attacked by the Mussel-scale, no time should be lost, and giving the stems of the

trees a thorough scrubbing with a hard brush, using hot kerosene emulsion for the purpose, is the best plan which I know of to check Scale of any kind upon the stems of trees.

When the insects have securely fastened themselves to the branches, the task of destroying them becomes more difficult, and only by spraying the trees thoroughly with either the strongest washes, or with the excellent resin compound, as recommended by Mr. Koebele, the well known American entomologist, and others. All prunings of the trees should be gathered up and burned, and no rubbish of any kind should be permitted to remain in any well-kept orchard. During the winter is the best time to tackle these little pests, because the trees being then without leaves the spraying can be done in a more thorough manner, which when the trees are in leaf is next to an impossibility; still, even at this time the Scale will require at least close attention.

Painting the tree with a weak solution of corrosive sublimate should be tried first on a small scale.* I have great hopes of this as a preventative against Scale, &c. The use of common starch for destroying Scale insects is, by some, thought to be an excellent remedy, but the starch would, I think, be of more use in treating for the Red Scale of the orange and lemon, as the soot fungus (*Capnodium citri*) is generally found where the Orange Scale is bad, this singular fungus being parasitic on the sugary secretion of the scale insects, as also on similar secretions of the *Aphidæ*, &c.; and, as Mr. Maskell has with truth said, "the first effort of the gardener, on the appearance of the sooty blight on his plants, should be to discover the insects on its leaves or bark, and deal directly with them. Once they are destroyed, the fungus growth will in a short time disappear;" and as the females of the *Coccidæ* are enabled to bring forth young without the assistance of the male, it is (as Mr. Maskell remarks) one of the most mysterious things in nature.

* The solution should be a very weak one, and should be used with great caution and only as an experiment.

Scale insects have many parasites; but, as I said before, I should not advise any grower who is badly troubled with Scale of any kind, to depend too much upon the assistance of parasitic insects; still they are, without a doubt, valuable auxiliaries, this much having been proved over and over again.

Mathew Cooke mentions that he believes, in America at least, there is but the one brood in a year. This should be encouraging news for us; but as a change of climate often causes a change of condition both in plants and animals, we must not trust too much to the chances of its being proved that there is only one brood of the Apple Scale in Victoria, as the fact has yet to be determined by patient observation and research.

PLATE VIII.

"Apple Beetle" (Doticus pestilens.—Oliff).

Fig.

1. Stem of apple tree, showing effects of beetle on fruit, the small hole in each apple being where the fruit nas been perforated. Natural size. (From nature.)
2. Larva (or grub). Magnified. (From nature.)
3. Larva (or grub). Natural size. (From nature.)
4. Perfect insects. Magnified. (From nature.)
5. Perfect insect (male). Natural size. (From nature.)

5A. Perfect insect (female). Natural size. (From nature.)

6. Outline of head of perfect insect. Highly magnified. (From nature.)

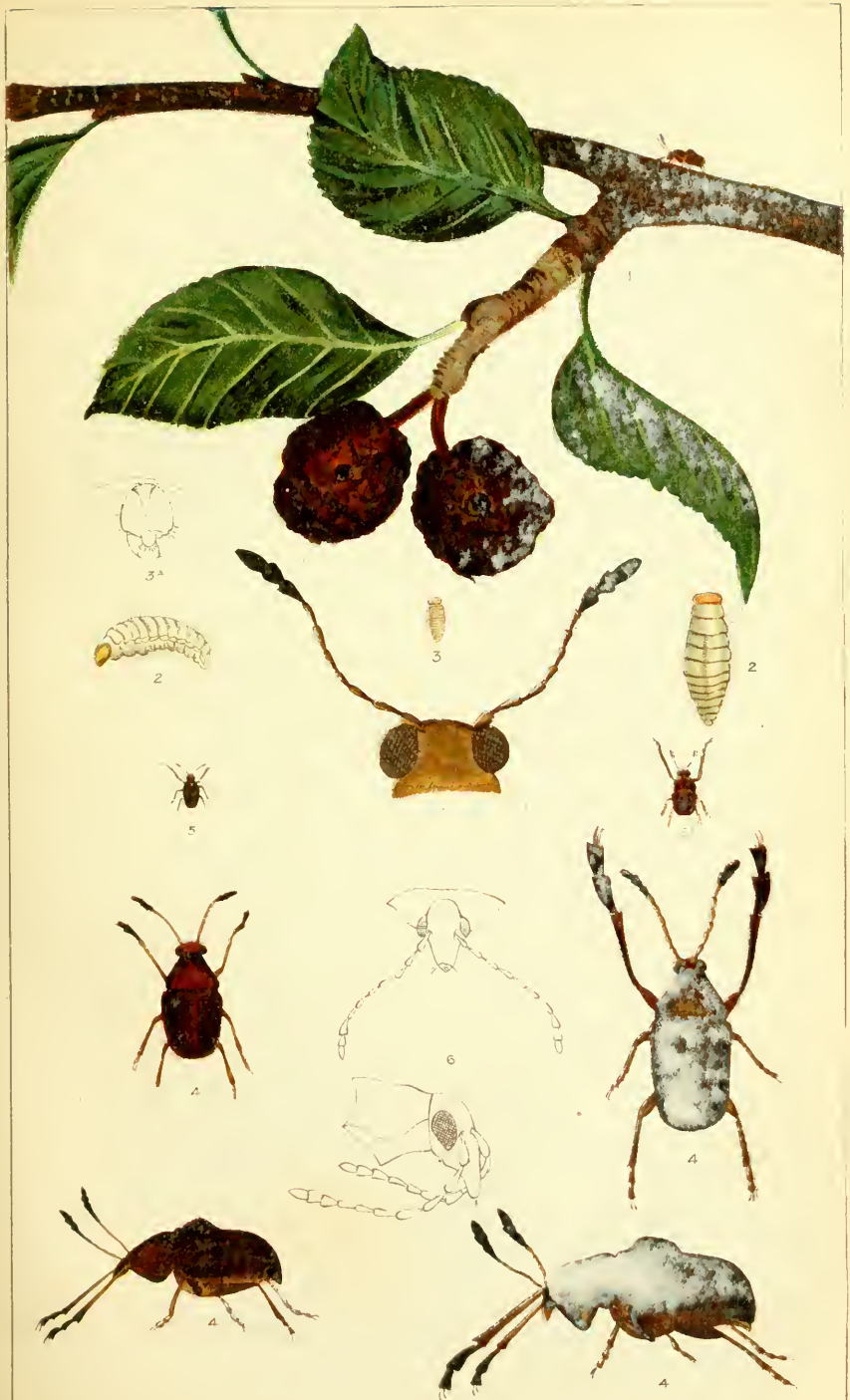


Plate VIII.

CHAPTER XIII.

THE APPLE BEETLE.

(*Doticus pestilens.*)

Order: *Coleoptera.* Family: *Anthribidæ.*

About the middle of November, 1889, I received from Mr. Stiggants, orchardist, of Warrandyte, Victoria, specimens of a little known but very destructive beetle, together with a quantity of shrivelled apples. The insect being quite new to me, I sent it to Mr. Oliff, in Sydney, with the request that he would examine and compare it with beetles in the very rich Sydney collections, and, if new, describe it. Upon examination, Mr. Oliff found that this particular Apple Beetle was new to science, and he has, from the information furnished by myself as to its depredations, given it the very appropriate specific name of *pestilens*. This new destroyer of apples is a small brownish beetle measuring about two lines in length (see Plate VIII., Figs. 4, 5, 5A), covered with reddish-grey down. The *antennæ* (horns) being slightly clubbed, *elytra* (wing cases) having upon them a row of small tubercles. Legs very long for so small a beetle. Perfect insect, very active, propelling itself, when not on the wing, with a short jerky motion. The grubs are small, and of a yellowish-white colour, as shown in Plate VIII., Fig. 2; and it is supposed that the egg or eggs are deposited by the female insect in the fruit, shortly after its being formed on the tree.

Mr. Stiggants informs me that the perforated fruit, as shown in Plate VIII., Fig. 1, will remain upon the tree the whole year, and, in the centre of these shrivelled fruits, the grub lives and undergoes its various changes (metamorphoses), and finally, at the commencement of the fruit season, is ready to deposit its eggs in the early crop of apples.

The fruit, when attacked by the grub of this beetle, will remain for about a month before it shows any decided signs of shrivelling, when the apples wither and dry up, as shown in our illustration.

Upon inquiry, I find that this most formidable pest was observed by Mr. Stiggants about two years since. The apples first attacked being the well-known varieties Reinette du Canada, Emperor Alexander, and Winter Majetin, all of which, Mr. Stiggants tells me, were purchased from some nurseryman at Kew, Victoria.

Mr. Stiggants thinks that, before finding out how this active and destructive little beetle worked, many of his neighbours have attributed the damage done by this beetle to the apple to have been caused by the Codlin Moth. It would be very interesting to find out for certain the exact period at which the eggs of this insect are deposited, also how long the young grubs (or larvæ) take to hatch from the egg, or how many eggs the female deposits in the fruit; and this, as well as any other information bearing upon the life-history of any particular insect (especially of one so destructive and new to science), will always be thankfully received and duly acknowledged.

The question has been asked "Whether I think this little pest to be a native of Victoria?" This is a somewhat difficult question to answer, as the family of *Anthribidæ* are but poorly represented in Australia, it being in the tropics and in the beautiful Malayan and Papuan group of islands where the largest and most singular forms of this family are found, and I am inclined to think that this particular species is an importation either from Queensland, or from some of the Polynesian group of islands, from whither they may have come in either fruit or fruit boxes.

Mr. Oliff, it may be mentioned, speaks of another species of this genus, viz., M. Mastersii, as being in the collection of the Australian Museum in Sydney, and which in appearance seems to resemble closely the new species which he, Mr. Oliff, has at my request been good enough to describe.

Prevention and Remedies.

As this new pest is a very active flyer, it behoves growers to be on the alert, and to use the spraying pump as soon as ever the fruit is properly set; and, as the use of London Purple has proved so efficient against the codlin and light-brown apple moths, there is no reason why it should not act with good effect in combating the ravages of this beetle. (It would, of course, be unwise to use any spraying material whatever whilst the blossom was still on the trees, as such an application would in all probability prevent the proper and regular setting of the fruit.) Before and after the unaffected fruit has been gathered, it would be well to at once pick off and destroy by burning all infested apples; and, in the event of any of the perfect insects being concealed beneath the loose bark or the crevices of the tree, after removing any lichens, loose bark, and other hiding places for insects, the tree should have a thorough spraying with either the "Kerosene Emulsion," "Resin Compound," "Quibell's Disinfectant," or any other well-tried solution.

The good old plan of "painting" the trees with a coating of lime and sulphur is not to be despised or set aside for some of the more active remedies.

There is one thing which should always be remembered in treating trees against the perfect insect, because it is a well-known fact to entomologists that a large proportion of the whole group of the *curculionidæ* and allies are, in the beetle stage, very tenacious of life, so that no reasonable amount of spraying (except perhaps with Benzole) would have much effect upon them, so we must tackle them whilst in the grub (or larval) stages.

Adhere to the good old rule—viz., to keep the orchards as free from weeds, rubbish, and litter of all kinds as possible. The tufts of greyish-looking lichens before alluded to (and often called by growers moss) being a specially secure hiding-place for insects of all kinds, clean these off the trees at once, and, after having done so,

give the trees a thorough spraying, both against insects and the resting spores of fungi, using the "Bordeaux Mixture" against the latter. And, having noted the habits of this and other insects, we may be able to find out their weak points, and, profiting by it, attack them accordingly.

PLATE IX.

"Harlequin Fruit-Bug" (Dindymus versicolor).

Fig.

1. Apple branch and fruit, the fruit showing signs of decay, where insects have pierced it. Natural size. (From nature.)
2. Adult female. Natural size. (From nature.)
3. Adult female. Natural size. (From nature.)
4. Adult female (underneath view). Natural size. (From nature.)
5. Larvæ about two-thirds grown. (From nature.)
6. Head, antennæ, and proboscis. Magnified. (From nature.)
7. Section of fruit showing damage. (From nature.)



C. Brittlebank. del. C. French. Direxit. Troedel & Co Lith.

Plate IX.

CHAPTER XIV.

THE HARLEQUIN FRUIT BUG.

(Dindymus versicolor.)

Order: *Hemiptera.* Sub-order: *Heteroptera.* Family: *Pyrrhocridæ.*

A very handsomely marked Tree or Wood Bug, length of body about 5½ lines, colour—orange-red, black and yellow (see Plate IX., Figs. 2, 3, 4, and 5).

This insect, which is a native of Victoria, has also been found in South Australia, Queensland, Tasmania, and in New South Wales; and Walker* mentions the fact of a specimen having been presented to the British Museum by the late Earl of Derby, as far back as 1845, so that, unlike the "Apple Beetle" previously mentioned, it has been under observation for many years. The eggs of this noxious Wood Bug are deposited during the late summer months amongst rubbish, under logs, stones, in crevices of old posts and rails, and in decayed wood, or even in stubble. The young, when hatched from the eggs, are funny little creatures, which emit, upon being handled, an abominable odour (a peculiarity noticeable with bugs in general). The small larvæ, which upon hot days are both numerous and active, are to be found in swarms upon plants of many kinds, also on fences and amongst rubbish. When about half-grown, the young, both male and female, are much more highly coloured than when the mature stage is reached, but are destitute of wings until the perfect insect is nearly developed, when they fly readily. In former years, these insects, although always looked upon as a nuisance, had not, so far as I am aware, given their attention to the destruction of apples, and it was not until late last season that Mr. Lidgett, farmer, of the Pentland Hills, in the Bacchus Marsh district, Victoria,

* Catalogue of *Hemiptera Heteroptera* in the British Museum.

discovered these bugs to be the cause of his apple crop having been partially destroyed, by these insects inserting their rostrums (or beaks) into and through the rind of the apple, thereby extracting the juices, and causing the apple to "spot," and become disfigured (see Plate IX., Fig. 1), and he, Mr. Lidgett, has also kindly sent me the specimens of the fruit and insects from which our drawings are made.

Growers of strawberries have a wholesome dread of Plant Bugs, and in America and elsewhere some kinds, such as the "Chinch Bug," the "False Chinch Bug," and others, are amongst some of the worst pests with which the orchardist has to contend. Fortunately, however, this class of insects do not, excepting in very isolated cases, deposit their eggs in or on the fruit, and thus growers are in a better position to successfully attack them.

Prevention and Remedies.

Keep all head-lands and other vacant places as free from weeds, logs, stones, and rubbish of any kind as possible, burning same on the ground if it be practicable to do so. Use lime freely, as fortunately the young at least of these bugs are easily destroyed. Tar-water, say 2 lbs. (coal tar) to 100 gallons of water, is an excellent thing to water with over bare spots or amongst infested plants, &c. Large numbers can also be shaken off into an expanded umbrella or a piece of old blanket smeared with kerosene. When the fruit is ripening, and these pests attack the apples, so that the trees cannot be shaken with safety to the fruit, burn some damp grass or cow-dung under the tree, when, if the smoke be dense enough, hundreds will drop to the ground, and can be destroyed by beating with a handful of boughs, and benzole, if properly applied (as per directions given in the chapter specially devoted to such matters), is very deadly to insects in general, and bugs in particular; it has also the merit of being perfectly safe, and leaves neither

taste nor smell on the fruit. The passing of a sectional or spiked roller over land infested by these insects, as also by slugs, is a good plan, and, where the natural configuration of the land will permit such, it should always be done.

This pest, although bad enough, is one which, in my opinion, can, with a little trouble and care, be very soon stamped out; and, as the country becomes more opened up, and the refuse burned, the breeding places of these and other insects will become lessened; and, if it be not possible to altogether destroy them, they can at least be held in check, and kept within manageable limits.

PLATE X.

"Red Spider" (Tetranychus telarius).

Fig.

1. Young state. Highly magnified. (From Murray's aptera.)
2. Perfect insect. Male. Highly magnified. (From Murray's aptera.)
3. Perfect insect. Female. Highly magnified. (From Murray's aptera.)
4. Tarsus (or foot). Highly magnified. (From Murray's aptera.)
5. Mouth and palpi, and one mandible. Highly magnified. (From Murray's aptera.)
6. Portion of apple branch, showing effect of Red Spider on leaves. (From nature.)
7. Perfect insect. Slightly magnified. (From nature.)



C. Brittlebank del. C. French Direxit. Troedel & Co Lith.

Plate X

CHAPTER XV.

THE RED SPIDER.

(*Tetranychus telarius.*)

Order: *Arachnoidea.* Section: *Tetranychidæ.*

This enemy of the orchardist and gardener generally is unfortunately but too well-known to need a lengthy description, but, as the matter of its life-history is so interesting, and at the same time instructive, I have ventured, for the benefit of the growers themselves, to furnish them with the most excellent account of this mite, as given in the well-known and valuable book on "Economic Entomology, *aptera*," by Andrew Murray, a work which cannot be too highly recommended, both for the use of entomologists and horticulturists generally.

Mr. Murray, in his remarks (which, to save space, I have occasionally abbreviated) says:—"That the genus shows a special affinity with its allies, the spiders, some of the species at least being endowed, like them, with the power of spinning a web, for which purpose the claws of the feet (see Plate X., Fig. 4) are specially adapted, being very short, and much curved, and provided with long stiff hairs, some of which have globular terminations, and are thought to be an essential part of the spinning apparatus. The mouth has a sucking apparatus (see Plate X., Fig. 5). This species has been found on a great variety of plants, and, from its form and manner, it was supposed to be the same on all of them long before this had been proved by breeding them, a conclusion which could not have been arrived at had reliance been placed upon their colour, for some are greenish, and marked only with brown specks on the sides, but variable, and evidently dependent on the alimentary matter with them; others are rust-coloured, or reddish, or brick-red, and that is the colour with which horticulturists are most familiar.

"Upon the Holly-hock Duges found, at the same time, individuals presenting almost all shades of colour, a circumstance probably connected with some peculiarity in the nutrition derived from that plant. On the vine, Dr. Johnston found the colour to vary in intensity in different individuals. So far as our own observation goes, the rusty colour is an indication of greater maturity than the green. This, and most if not all the species of the genus, spins a web on the back of the leaves of the finest and most delicate texture. The threads of its web are secreted from a conical nipple situated underneath, and very near the extremity of the abdomen. They are drawn out and guided by the motions of the insect, and by the action of the minute claws and hairs of the legs, which seem to be only used for this purpose. The threads are so slender that we fail to see them, even with the assistance of a magnifier, until after they are woven into a web, or network. In the construction of this web all the feet are moved with great agility, but the movements of the mite itself are not quick, and it moves with difficulty over smooth and polished surfaces, as over glass. Upon leaves, especially on the under side of them, it finds a better hold, for, supported on the bristles that extend beyond the claw, it spins its web, affixing the threads to the prominences and hairs of the leaf; and under this shelter a colony, consisting of many of both sexes in maturity, and young in all their stages, feed and mulitply with rapidity.

"The plant soon shows the influence of their presence in its sickly yellow hue (see Plate X., Fig. 6). The sap is sucked by myriad insect mouths from the vessels of the leaf, and its pores are checked by excremental fluids. The mode in which they feed is by eating their way into the leaf with their nipping mandibles (see Plate X., Fig. 5), and then plunging in their barbed suckers, and sucking the juice.

"The egg of this mite is spherical, colourless, and proportionately large. The larva which comes from it is minute, transparent, and in shape not unlike the parent, but it has six legs only (see Plate X., Fig. 1), and creeps very slowly.

"M. Duges says that it undoubtedly passes through the immovable nymph or pupa state, before the full complement of legs is acquired. M. Duges believes that these mites pass the winter under stones, concealing themselves there when the infested leaves have fallen. In a garden near Paris he found several individuals thus concealed in the month of October; they were of a uniform brick-red colour, and had lost as yet none of their agility, nor of their spinning power; and on them he observed most distinctly the secreting papilla of the thread.

"The leaves which are attacked have a languishing air; they are yellowish or greyish above, with some patches of a lighter shade forming a kind of marbling; their edges are slightly folded back, and, as if they were slightly rolled on the under side, the lower side is white and slightly shining. If in that state we examine with the microscope the under side of the leaf, we find swarms of individuals of all ages, as well as the eggs, pasted to the warped stuff on the leaf."

There are, according to Mr. Murray, in addition to several named varieties of the true "Red Spider," fourteen or fifteen distinct species of this genus, many of which, unlike the Red Spider, seem to confine themselves to particular plants, and have been named after the plants on which they feed, as *T. Cucumeris*, or Spider of the Cucumber family; *T. Rosarum*, or Spider of the Rose; *T. Vitis*, or Spider of the Vine, and so on; and doubtless in many cases these latter species have been mistaken for the true Red Spider, *T. Telarius*. Further investigations, we hope, may enable us to state positively whether we have amongst us any of the additional kinds above alluded to.

As the vine-growing interest is of such great importance in this colony, it may be well, in the event of the Vine Spider making its appearance in our vineyards, to give a description of it from the pen of the well-known entomologist, M. Boisduval, as quoted by Andrew Murray:—

"When, towards the end of summer, we see the leaves of the vine marbled above with broad yellow blotches, it

is often the indication of the presence of a very small parasite, which lives in families on its under side. On examining such a leaf with a very powerful lens, we see at first that it is carpeted with a rather loose silken tissue, like very small spiders' webs, in the midst of which we can see numerous acarids of very small size moving about. They are greenish-yellow, transparent, a half smaller than the true Red Spider, to which they bear some resemblance. We (M. Boisduval) have not found this minute insect mentioned in any of the authors that we have consulted."

In Victoria this pest seems to have made considerable headway, and, in some of the drier portions of the colony, apples, almonds, and other fruits, to say nothing of vegetables, often suffer very severely. The worst case which has come under the notice of the writer being a crop of French beans growing in a slightly sheltered garden on the St. Kilda-road, the whole crop being badly affected, and the plants had to be pulled up and destroyed.

As showing the enormous numbers of these mites, it may be mentioned that on some of these bean plants the masses of red spiders were quite a quarter of an inch in depth, a statement which seems almost incredible; and in some parts of the colony fruit trees are often quite defoliated from the attacks of these tiny insects, the leaves falling and allowing the rays of the sun to penetrate into the tree, with the result that the bark becomes hard, and the fruit often "scalds," and drops off before being fit for gathering.

"Under glass" the red spider is a perfect terror to the gardener, although he has a better chance of fighting them when thus covered than when in the open air.

Prevention and Remedies.

Allow no stones, logs, or rubbish of any kind to exist in the orchard. Spray the tree with a fairly strong kerosene emulsion—say 1 in 25—when the tree is without leaves, and again when the fruit has been gathered. Sulphur in any form (crushed lump sulphur being

preferable to the so-called powdered sulphur) is very fatal to the Red Spider. Soft soap and Gishurst's Compound, as used by gardeners, are old and well-tried remedies, and, when the fruit is off the tree, tobacco water is a very good remedy against this and many other insects.

In using either the syringe or spraying pump against Red Spider, it should be remembered that the mites are mostly on the under part of the leaves, so that the various solutions must be sprayed in an *upward direction*, and with considerable force, otherwise the treatment will have very little effect on this pest at any rate. When a tree is badly attacked by Red Spider, shake as many leaves as possible off the tree into a sheet and burn them. Paint the stems with a hard brush, using slaked lime and sulphur mixed for the purpose. In a small garden, the sulphur bellows can be used with good effect. In heated conservatories, the best plan is to strew sulphur upon the pipes ; this, however, must be done with care, or else the tender plants may be irreparably injured, as it is imperative that a proper moisture be maintained during sulphuring time. In the kitchen garden, if beans, &c., are badly affected, destroy them at once, and constant hosing, especially where plants are under glass, is of great benefit as a preventive against the Red Spider, Thrips, &c. In large orchards the use of sulphur steam may yet prove the best remedy. For Crotons, Cordylines, and many other plants, dipping in a solution of tobacco water is an old and very effective remedy.

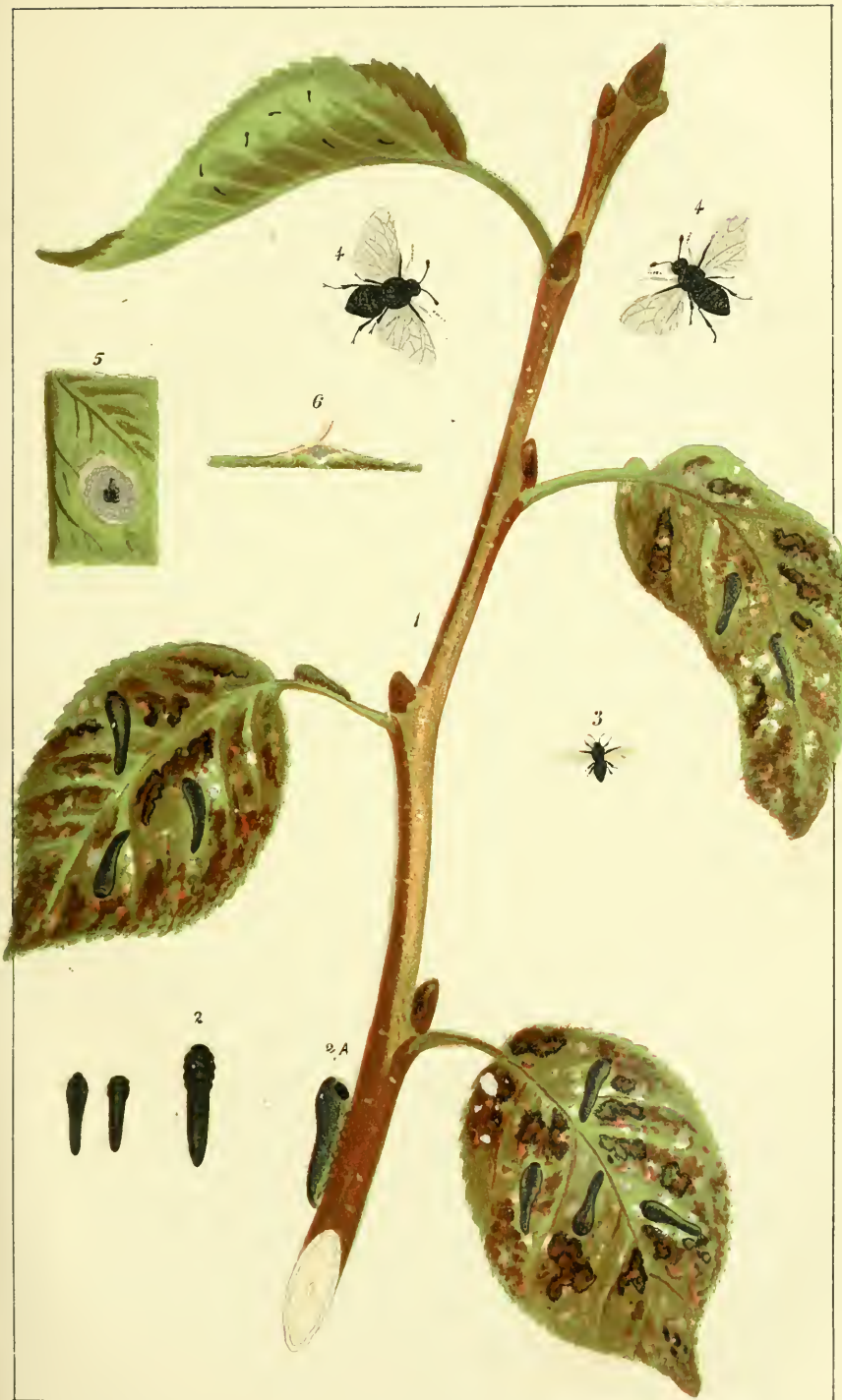
Luckily for growers, this pest is not difficult to destroy, but to do this the treatment should be carried out with both care and promptitude.

PLATE XI.

"Pear and Cherry-Slug" (Selandria cerasi).

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1. Branch of pear tree showing young larvæ, also upper surface of leaves destroyed. (From nature.)
2. Larvæ, slightly magnified. (From nature.)
2a. Larva ascending stem of tree. Magnified. (From nature.)
3. Perfect insect. Natural size. (From nature.)
4. Perfect insect. Magnified. (From nature.)
5. Section of pear leaf, with supposed eggs. (From nature.)
6. Section of edge of leaf with supposed eggs. (From nature.)



C. Brittlebank. del. C. French. Direxit. Troedel & Co Lith

Plate X.

CHAPTER XVI.

THE PEAR AND CHERRY SLUG.

(*Selandria cerasi.*)

Order: *Hymenoptera.* Family: *Tenthredinidæ.*

This most destructive insect, when in the larval state, is a small dark-green slimy caterpillar, infesting the leaves of both pear and cherry trees, which they injure very much by gnawing the epidermis off the upper portion of the leaves, leaving the skeleton and the lower portion of the leaves untouched.

Trees, according to Harris, attacked by this pest "are forced to throw out new leaves, during the heat of the summer, at the end of the twigs and branches that still remain alive. This unseasonable foliage, which should not have appeared until the next spring, exhausts the vigour of the trees and cuts off the prospect of fruit." But this is not the only damage for which the Pear Slug is responsible, as by destroying the epidermis of the leaves (see Plate XI., Fig. 1) the blazing sun of a Victorian summer is by this means enabled to penetrate with its full force right into the centre of the tree, thereby causing a shrivelling of the bark, scalding of the fruit, and otherwise injuring the trees.

The egg of this saw-fly is deposited in a cut made in the leaf by the saw-like ovipositor of the female, and Mathew Cooke tells us that as many as nineteen eggs have been found deposited in one leaf.

The larva (see Plate XI., Fig. 2) is, according to Harris, "hatched from the egg in two days, and feeds upon the leaves as described above. It attains its full growth in from 20 to 25 days. During the time it is feeding it exudes an olive-coloured slimy substance, which covers the body and gives it the appearance of a small tadpole. When it ceases eating it casts its skin and slimy coat, and appears with a clear yellowish skin; the

divisions of the segments of the body are plainly seen; it then descends to the earth and crawls beneath the surface from 1 to 4 inches, and forms a cocoon, where it undergoes its metamorphoses, or changes, and in about fifteen days the perfect insect appears." (See Plate XI., Fig. 4.) In America, according to Harris, "the first brood appears late in April or early in May, the second early in July. When the larvæ of the second brood are full grown they enter the earth, and remain unchanged until the following spring. It seems that all of them, however, do not finish their transformations at this time; some are found to remain in the ground unchanged till the following year, so that if all the slugs of the last batch in any one year should happen to be destroyed, enough from a former brood would still remain in the earth to continue the species."

Larvæ, when full grown, five and one-half lines. Perfect insect, body shining black, nearly three and one-half lines long, expanse of wings six lines, wings transparent.

This scourge of the fruit-grower is a somewhat recent introduction from either Europe or America, it matters not which; but, according to the most reliable information at my disposal, I find that it first made its appearance in Victoria at a private garden at East St. Kilda, near Melbourne, and is said to have come from a nursery near Auckland in New Zealand. The specimens of the perfect saw-fly, from which our drawings have been made, were taken by Mr. Knight, Government fruit expert, who, at my request, undertook to watch and wait for this destructive little brute, and although no one here had previously seen the "fly" I felt quite certain that we had the much dreaded European pear slug amongst us, and after several days of patient watching in the orchard of Mr. C. Allen, junr., of Cheltenham, Mr. Knight was fortunate enough to capture three specimens, two females and one male, these being, I believe, the first specimens of the perfect insect taken in Victoria, the difficulty of obtaining fresh food for the larvæ to feed upon being the principal cause of my having failed to rear them.

In speaking of the damage done by this insect it may be mentioned that both Mr. Neilson and Mr. Allen are of the opinion that the Pear Slug is the worst enemy with which growers of fruit have to contend, and surely when one sees the havoc done, more especially to cherry trees when the fruit is ripening, we cannot help agreeing with these and other growers that some combined action should be at once commenced against this new and much dreaded pest of the pear and cherry.

Prevention and Remedies.

Now that growers have been made aware of the real identity of the above insect, and have also learned something of its habits, the task of dealing with the Pear Slug in all its stages will, we hope, be considerably lessened.

The great difficulty in dealing with the above pest would seem to be in the fact of the larvæ being on the leaves when the fruit is either ripe or ripening, in which case the ordinary material used for spraying, as kerosene emulsion, the resin compound, London purple, and others, could not well be applied with safety, as the fruit would, in all probability, be rendered unfit for sale, caused by the presence of the flavour of either kerosene, tar, or eucalypti oil, to say nothing of the well-known poisonous qualities of London purple when not used at the proper time.

The best time to tackle the Pear Slug is before the fruit becomes far advanced, and not when the tree is in bloom, as the material, if used at this period, might prevent the fruit from setting properly.

Treat the roots of the trees as recommended for using against the apple root borer, both the bisulphide of carbon and Quibell's mixture being very good for the purpose, the effect of the latter being, however, of a more lasting nature, and at the same time not so offensive to use as the bisulphide of carbon. Sulphate of Iron (1 oz. to gallon of water) is also an excellent "ground" mixture.

As a material for spraying, when the fruit is not on the tree, the kerosene emulsion, say 1 part of the

emulsion to 25 parts of water, and sprayed on to the tree whilst hot, is about all that is necessary, although Mr. Neilson has informed me of his success with the crude oil of eucalypti, which he says is both cheap and effective. Dusting the trees with slaked lime mixed with sulphur is also an excellent remedy, and even sand or light dry soil shaken over the leaves will destroy the grubs, but not the eggs, hence the advantages to be derived from the use of more powerful remedies. When the fruit is ripe, if the slug is still in great numbers, try the benzole spray—equal parts of benzole and water—which must be kept well stirred whilst using. This material has been tried, where many other supposed remedies had failed, on the "Rutherglen Vine Bug," and even when the grapes were quite ripe, the berries, in a couple of days, were found to be quite uninjured, either in taste or smell, by the application of the benzole.

Some pieces of bagging damped with kerosene might also be placed under the trees, and into which the flies, at night or early morning, might be shaken.

In fighting the Pear Slug, do not be discouraged if your best efforts would appear to be of little avail, keep at it, give no quarter, and now that we have a clue to its habits, we have gained half the battle. Removing the surface soil, as recommended by Miss Ormerod and others, has proved very successful, as has also the application of quick-lime to the soil below the surface.

Before closing these remarks on the means adopted by others for the purpose of combating the ravages of this insect, I wish to draw attention to what appears to me to be a most valuable remedial measure. I quote from the late Mr. Crawford, who says, "I am indebted to Mr. George Goyden, junr., for the suggestion that iron sulphate (ferrous-sulphate, sulphate of iron, proto-sulphate of iron, green vitriol) might prove a remedy for *fusicladium* (scab fungus of the apple). According to Dr. Griffiths, of the Technical College, Manchester, iron sulphate acts on the soil as an antiseptic. Under the microscope, a very dilute solution of 1 to 1,000 destroyed the spores of the potato

disease and red rust. I would therefore recommend the same strength to be used as a spray, say one ounce to six gallons of water. In case this strength is found to have no effect on *fusicladium*, it might be doubled, I should think, without risk to tree, foliage, or fruit."

In reading these remarks in the report on the *fusicladiums* published by Mr. Crawford, of Adelaide, it has occurred to me that the iron sulphate ought to have a fair trial here as an insect destroyer also. It has of course been tried on the phylloxera, but I believe it has so far proved unsuccessful; let us hope for better results. Mr. Byron Moore, so well known in our city, from whom I have just received a letter informing me that, by a liberal use of the iron sulphate, he has been able to keep his tomatoes and other vegetables quite clear of both insects and fungi.

Mr. Crawford has made an estimate of the cost of the above solution, being, as he says, but a mere fraction of a penny per gallon.

Luckily for the growers of pears and cherries this slug is easily destroyed, so nothing else remains for us to do but to attack it persistently until we have it within reasonable bounds, when, by a little united action, it can without a doubt, be stamped out altogether.

PLATE XII.

"Rutherglen Bug" (Rhyparochromus ? sp.).

Fig.

1. Branch of cherry tree with fruit, and with insects. Natural size. (From nature.)
2. Perfect insect; under view. Magnified. (From nature.)
3. Perfect insect; upper view. Magnified. (From nature.)
4. Head of adult insect. Magnified. (From nature.)
5. Adult insect. Slightly magnified. (From nature.)

A. N. Caudell.

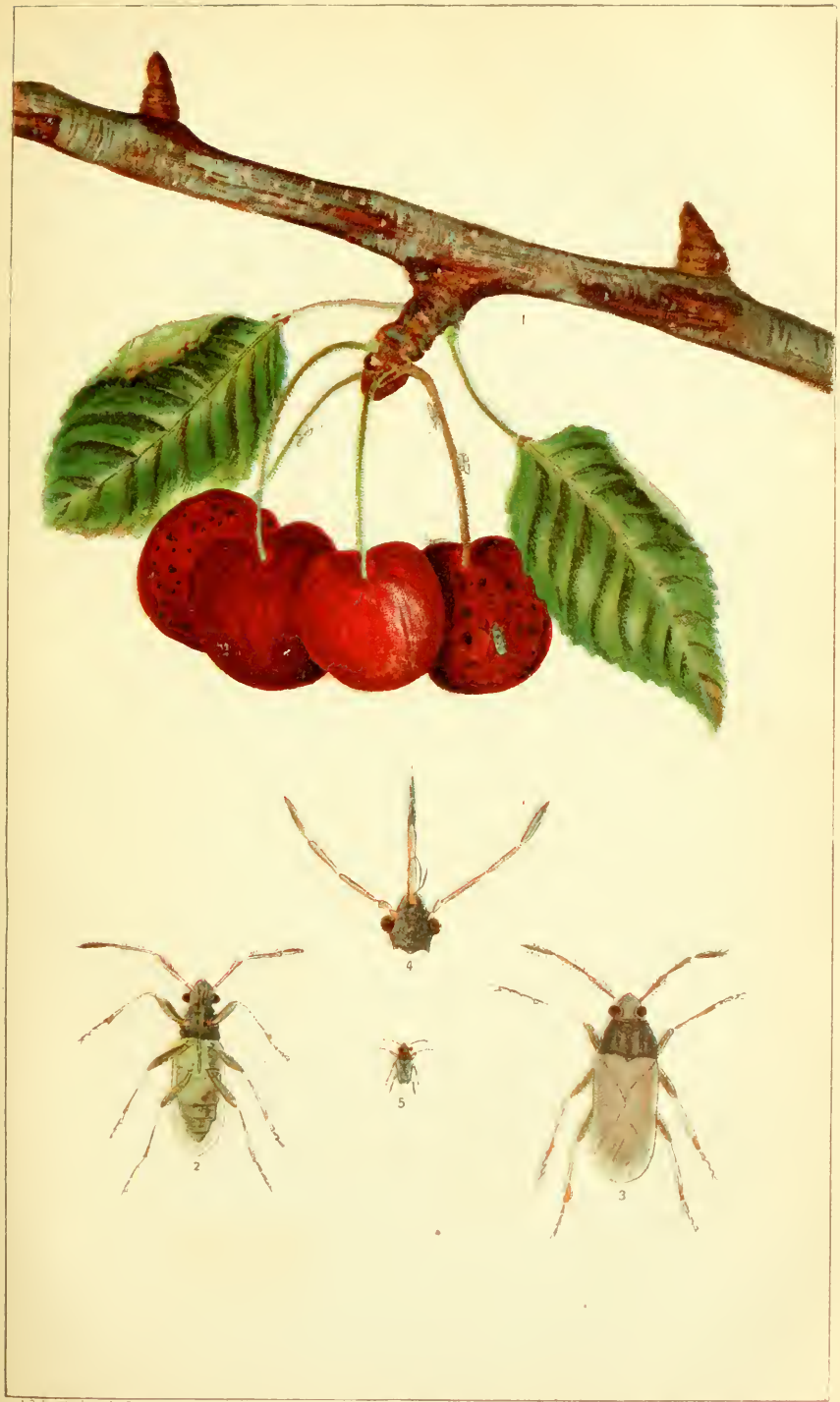


Plate XII

CHAPTER XVII.

THE RUTHERGLEN FLY-PEST.

(*Rhyparochromus sp.*)

Order: *Hemiptera Heteroptera.* Family: *Lygiædæ.*

A small insect belonging to the so-called "Wood Bugs" owing, I suppose, to the fact of the common House Bug belonging to the same natural order of insects. This comparatively new pest is about two lines in length, the body being of a light greyish-brown, but after nearly black.

Antennæ, or "feelers," barely two-thirds the length of the body, and covered with fine hairs. Wings quite transparent. Legs dirty yellowish white. Underneath the insect (see Plate XII., Fig. 2) can be seen the rostrum or beak, with which instrument the damage is done by piercing the fruit as described hereafter.

This Bug, the species name of which has not yet been determined, belongs to the family of *Lygiædæ*, and closely resembles in appearance the False Chinch Bug (*Nysius angustatus*) of North America, to which insect the "Rutherglen Pest" is closely allied. In America, the damage done by the latter insect is very great, and I have to thank my friend, Mr. West, our irrigation expert, for his thoughtfulness in sending me the specimens of the * "False Chinch Bug" from America for comparison and observation.

In the British Museum collection, there are no less than thirteen different kinds of the genus *Rhyparochromus*, labelled as having been sent from Australia, so that it is quite possible that we have to deal with a native insect, and not with an imported one. The common name of this insect is now so well-known, that I have hesitated to alter it, although, probably a much more appropriate name might have been adopted.

* Mathew Cooke calls the latter *Nysius destructor*, which name is possibly a synonym of *N. angustatus*.

The insects, figured as being on the stems of the cherries (see Plate XII., Fig. 1), are only slightly smaller than the natural size; and the black perforations, or holes, are intended to show where the fruit has been attacked and pierced.

Between three and four years ago, the rich Goulburn Valley and other North-Eastern districts, were visited by what the growers themselves took to be a small fly, which indiscriminately attacked many kinds of fruit, and a number of vegetables; but from the information which I could gather, I find that the number of these little insects was at first comparatively few, and could be dispersed by causing a smoke by burning cow dung, green leaves, &c.

Late in 1889, and up to the first three months in 1890, this terrible pest again made its appearance, and in such vast numbers as to cause considerable apprehension to vignerons, orchardists, farmers, and others. This somewhat sudden inroad of so formidable an enemy, caused the good people to wonder what was going to happen next, and being in this dilemma, applied for the services of the Government Entomologist to assist them with his advice, and to provide if possible some remedy; and the matter being a very urgent one, Mr. Knight, fruit expert, was sent up to Rutherglen for the purpose of trying several supposed remedies, which in our innocence, we thought would banish the "Fly," bag and baggage, but in this, however, we were grievously disappointed, until at length, after trying such material as one might reasonably suppose would be fatal to such minute soft-bodied insects, I was asked to visit the district, and, if possible, to do something more than had already been done to combat them. In accordance with the wishes of the growers, I proceeded to the Goulburn Valley, Rutherglen, and other places in the North-Eastern districts, and here I found the pest more numerous, and the extent of damage done by it more serious, than I could possibly have anticipated, acre after acre of grape-vines, with the fruit fast ripening, were literally covered with these tiny Wood Bugs, which by introducing their rostrums, or beaks (see Plate XII.,

Fig. 4) into the fruit, and thereby sucking out and absorbing the juices, caused the fruit to shrivel up, become dry, and perfectly useless for either the table or wine-making. Other fruits, as apricots, plums, cherries, and peaches were in many cases rendered perfectly useless and unsaleable; the peaches and apricots especially having both the appearance and texture of leather.

In vegetables, potatoes and tomatoes were specially visited by this pest, and in many cases the crop was partially if not wholly destroyed What was to be done? And being in this fix, it occurred to me to try the use of benzole, by using it with a spray-pump, I having used the former material for many years as a destroyer of insects of all kinds, especially the minute Beetles and Acari which do so much damage to furs, as also to preserved collections, both entomological and botanical. Accordingly some trials were arranged for, these taking place by permission of several of the vignerons in the district. The day was very hot (nearly 100 in the shade) and the Bugs were in countless numbers, covering the berries of the nearly ripe grapes until the latter were hardly recognisable. We set to work with the benzole and the effect was almost magical, as the distribution of the benzole by means of the "Crawford Spray-pump" was so fine and mist-like that every insect touched by the material fell to the ground. A few managed to partially revive, but the great majority were killed almost instantaneously. We then, by agreement, allowed the fruit which had been treated to remain about forty-eight hours on the vine, the result being, that, at the expiration of that time, the grapes were perfectly free from either the taste or smell of the benzole, and the bunches so treated were brought to a meeting of the local horticultural society at Rutherglen, at which many representative gentlemen of the district were present.

The geographical range of this comparatively new pest would seem to be very great; I having first received them from the Upper Yarra, near Beenak, a locality which has the heaviest rainfall of any part of the colony, where the insect had attacked the potato crops. I next received

them from South Gippsland, then from Ballarat, Corowa, and even from Adelaide and other parts of South Australia, showing that this insect, although small, requires to be well watched, otherwise the consequences to growers may be most serious.

Prevention and Remedies.

Keep orchards, vineyards, and gardens as free as possible of weeds and rubbish of any kind, and a sectional roller if passed over headlands, when practicable, would be the means of destroying not only a large number of the insects themselves but of their eggs and larvæ also. Sulphate of iron, in the proportion of say one ounce to each gallon of water, has also been tried with good effect on insects of many kinds (that is, of course, whilst the insects are in the egg and larvæ stages). The "forking or ploughing in" of a little gas-lime into the soil is also useful, as it is supposed that the eggs of these little Wood Bugs are deposited either amongst rubbish and weeds, or beneath the soil; but this fact we have so far failed to trace with any degree of accuracy, although many devices have been resorted to by those growers who have kindly assisted us to find out where the eggs are deposited. One of the most singular circumstances connected with this little pest is its extreme activity, and its apparent immunity from the usual results of the application of strong solutions. At Rutherglen and Barnawartha, places in the great vinegrowing districts of Victoria, we tried kerosene emulsion and soap, rectified spirits of wine, insect powders (several), and fusel oil (undiluted), but all to no purpose, the benzole alone seemed to be the only thing which had the merit of instantly destroying the insect without injury to the fruit. "Quibell's mixture" was fairly successful in killing the Bugs, although it left a decided flavour of tar upon the fruit.

When this pest again makes its appearance some concerted action must be at once taken for the purpose of destroying as many of the insects as possible. In the case of ripening fruit of any kind, London purple, Paris green,

and other arsenious preparations should *not be used*, and the same remark will apply to any tree when in bloom, as the applications of such solutions may not only injure the flower and prevent the fruit from setting properly, but bees in visiting the trees may become poisoned and the honey possibly injured.

In the "Rutherglen Fly-pest" we have an insect which will thrive even on ripe capsicums, and remain uninjured after a heavy spraying of fusel oil, and, at present, benzole, in some form, although perhaps expensive, seems to be the only remedy which can safely be relied upon.

The old system of driving away insects from orchards by means of smoking is, at the best, a half-hearted measure, as the pest, instead of being destroyed, is merely driven into the orchard or vineyard of one's neighbour, which we must admit is a somewhat selfish proceeding. Every possible perseverance should be used in endeavouring to find out the place in which the insect deposits its eggs, as having once gained so much knowledge, we may be the better able to cope with this serious enemy of the vigneron and fruit-grower.

The agriculturist is however, by no means exempted from the losses occasioned by the attacks of this pest, as it has proved to be terribly destructive to green maize as also to potatoes. It behoves all those interested in rural pursuits to unite in this and in other cases whenever a new destroyer, whether it be insect or fungoid, makes its appearance in our midst.

Before closing these remarks on prevention and remedial recommendations, it may be well to draw the attention of growers to a remedy which has, according to Mathew Cooke, been tried with success against the "False Chinch Bug" in America, in which it is stated that "Early in spring (or as soon as the insects appear on the plants or vines), place loose straw, hay, or other like material around or under plants or vines, so that the insects can take shelter at night; in the morning before sunrise remove the material laid down and burn it. I recommended this for the destruction of the 'False Chinch Bug' on grape vine.

The vine-owner reported success; but he sprinkled some coal oil on some straw, which he placed on the ground under the straw taken from around the vines, and in this way prevented the insects from escaping into the ground while the straw was burning, making the application a complete success."

PLATE XIII.

"Cherry Borer" (Maroga gigantella).

Fig.

1. Cherry branch attacked by borer, appearance of sawdust-like covering, indicating grub at work. (From nature.)

1a. Branch with covering removed, showing damage done by larvæ. (From nature.)

2. Larva in bore, where it retires when not feeding. (From nature.)

3. Larva (or grub); top view. Natural size. (From nature.)

3a. Larva (or grub); under view. Natural size. (From nature.)

4. Head, and first three segments of larva; side view. (From nature.)

4a. Head, and first three segments of larva; ventral view. (From nature.)

5. Perfect insect. Natural size. (From nature.)



C. Brittlebank Del C. French Direxit. Troedel & C° Lith

Plate XIII.

CHAPTER XVIII.

THE CHERRY-BORER.

(*Maroga gigantella.*)

Order: *Lepidoptera Heterocera.* Family: *Gelichidæ?*

This pest of the cherry and peach grower is a Moth, the larvæ of which are terribly destructive to cherry and peach trees and sometimes to plums.

The larva is a pinkish-white grub (see Plate XIII., Fig. 3), hairy, and when full-grown, about two inches in length.

The perfect insect (see Plate XIII., Fig. 5) is white, shining; head in front and antennæ black; fore-wings, in some instances, more or less greyish, the whole wings having a somewhat silky appearance, with a black spot on each; hind-wings darker, fringe white; length of the body, 10–12 lines; spread of wings, 20 to 30 lines. This insect (it is supposed) also attacks elm trees by boring into the thick branches, and is one of the worst of the wattle-borers, and has left its native food for the less bitter wood of the cherry and peach.

Until quite recently, many persons have had their doubts as to the proper identity of this Moth, as the rearing of the grubs from the wood is, in some cases, a difficult matter; in others again, as several moths and beetles, nothing is easier, and I must confess a doubt as to whether I had got hold of the real culprit.

I am indebted to my friend, Mr. Henry Edwards, the well-known entomologist, now of America, who collected around Melbourne in the early days of the colony, for the proper identification of this insect, as he (Mr. Edwards) informs me that 30 years ago or more the same insect destroyed nearly the whole of the cherry trees in the old garden of the late Hon. H. Miller, who then lived at Richmond, and Mr. Edwards at once recognised both the larvæ and the perfect insect, he having reared it from the cherry-wood. The larvæ of this Moth have also been

known to attack plum, apricot, nectarine, and even quince trees. (H. Edwards.)

The name *Maroga gigantella* has been adopted from "Walker's list." Mr. H. Edwards, however, in a very interesting paper, read recently before the Linnean Society of New South Wales, calls it *Cryptophasa unipunctata* (Don), and remarks that the insects are easily attracted by a light, so that the lamp [an engraving of which is here given] should be of extra value in the capture of this and other nocturnal kinds of insects.

The larvæ of this Moth destroy the trees by boring, first tunnelling for some distance under the bark, and then gnawing their way right into the very heart of the tree (see Plate XIII., Fig. 3). The sawdust-like excrescence on the trees being quite sufficient indication of the presence of borers in general, and this one in particular.

The jaws of the larvæ are very strongly made, which enable them to gnaw with great rapidity, it being perfectly surprising to find what a large amount of damage they are capable of doing during a single night. As an instance of the boring power of some even small grubs, I may mention the fact of the larva of a moth (the former about an inch in length) in one night having bored through a box in which I had had the grub confined, and nearly through a thick table of old seasoned cedar, so that in green wood it is hardly to be wondered at when they do so much damage to trees.

The losses caused by the depredations of this insect are very serious, and if not at once attended to, the grower of both cherries, peaches, and even apricots may suffer more severely than they have hitherto done.

Prevention and Remedies.

Remove, or if possible have removed, all old and badly-infested wattle trees growing in the vicinity of the orchard. Give the tree when dormant a spraying or two with either kerosene emulsion, tar-water, Quibell's mixture, Phenyle, or any other solution which would tend to make

the flavour of the surface of the bark unpalatable for the female to rest upon for the purpose of depositing her eggs. After pruning, paint the stumps with a solution of tar and grease. Remove all loose bark, and daub, with a common whitewash or similar kind of brush, any of the solutions into the crevices or crutches of the tree; and to prevent the larvæ from descending from one tree and ascending another, a good plan would be to paint the lower portion of the stem with a mixture of kerosene, lime, tar, and grease.

When the presence of this borer is suspected, first clear away the sawdust-like matter before mentioned, the removal of which will indicate the direction taken by the grub, but as the holes are usually made in a horizontal position, the ordinary method of spraying should be somewhat departed from. If the spraying pump and nozzle be used, project, with as much force as can be commanded, the liquid into the hole, being guided by the direction taken by the grub.

In gardens where there are but a few trees, small pieces of stick dipped in a mixture of tar and carbolic acid (three parts of the former to one of the latter) could be driven into the holes, which will, in most cases, cause the grub to at once shrivel up and die. In large places this method would be, perhaps, too tedious, still the services of children might be utilized with advantage for this purpose, as the little sticks could be prepared by night around the family fire; and any active boy could go over a large number of trees in a very few days. The little sticks, as also the solution, could be carried in an old tin billy in front of the operator.

As the grubs of this Moth, if not destroyed, remain a long time in the trees (how long has not, I believe, been well ascertained), it will be all the more necessary to tackle them at once, as prevention is, after all, said to be better than the cure.

The use of a lamp, such an one as is figured in this book, might be also tried with advantage in capturing

the Moths, both males and females, which as a rule are not numerous.

The forcing of steam into the holes made by this and other boring insects would, I feel certain, be of great benefit, and as the Moth itself is not of a small size, and by its colour is somewhat conspicuous, there should not be much trouble in combating the ravages of this pest.

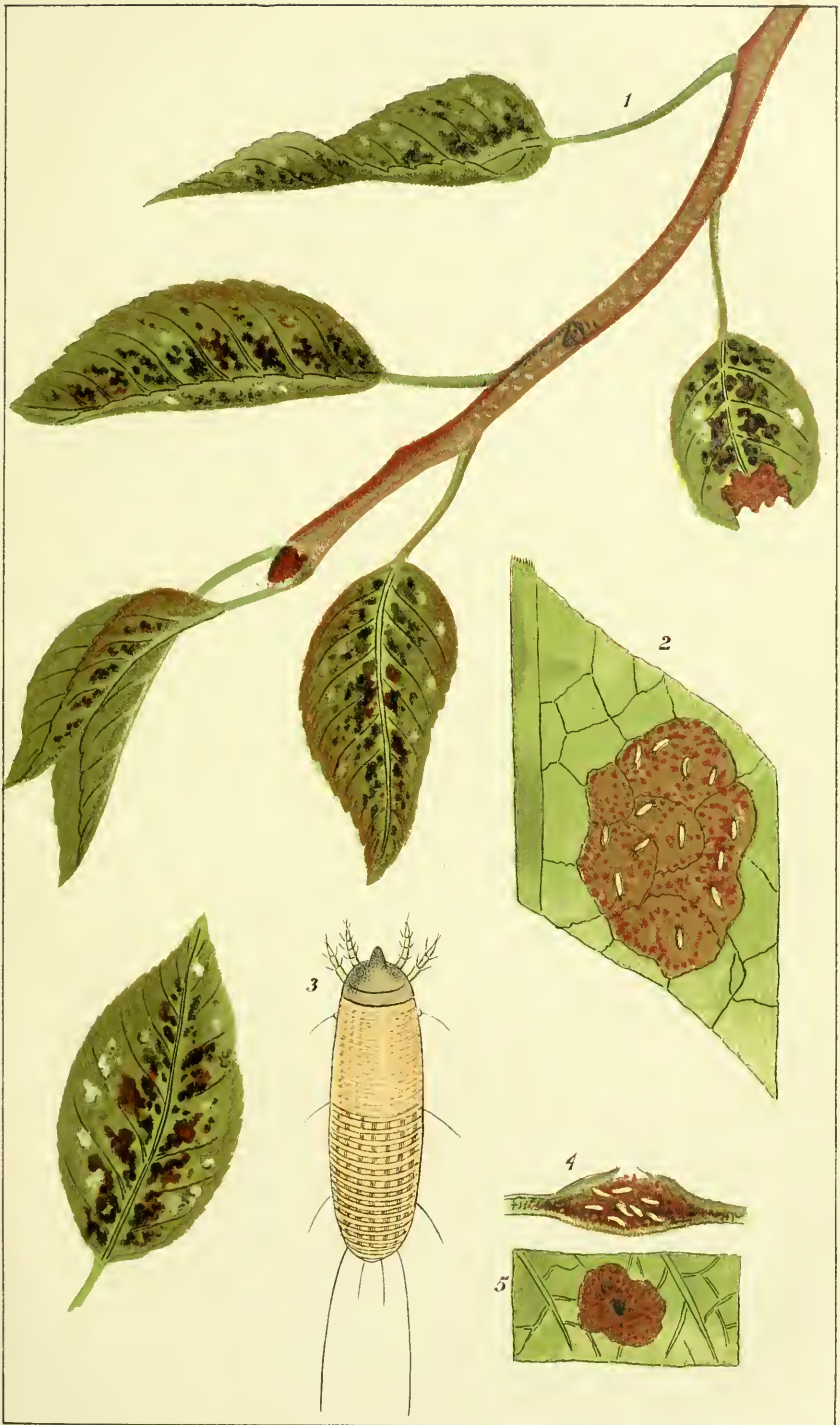
Old and abandoned orchards are fertile sources of infection, and should be carefully watched by growers and by all interested in fruit-growing as a profitable industry.

PLATE XIV.

"Pear Phytoptus" (Phytoptus pyri).

Fig.

1. Pear branch, showing injury done to leaves. Natural size. (From nature.)
2. Section of pear leaf, showing galls and insects. Magnified. (From nature.)
3. Perfect insect. Highly magnified. (From nature.)
4. Section of gall with insects. Magnified. (From nature.)
5. Gall, showing chamber from which the little insects have escaped. Magnified. (From nature.)



C. Brittlebank Del. C. French Direxit. Troedel & Cº Lith.

Plate XIV.

CHAPTER XIX.

THE PEAR PHYTOPTUS.

(*Phytoptus pyri.*)

Order: *Arachnoidea.* Family: *Acarinæ.* Sub-Family: *Phytoptidæ.*

Orchardists and others who are familiar with pear-growing will have observed the leaves of the pear tree to be partly covered with greenish-brown blister-like looking blotches (see Plate XIV., Fig. 1), rendering the trees very unsightly and causing them to prematurely shed their leaves, to the undoubted detriment of both the tree and its fruit.

This damage, then, is caused by a tiny insect belonging to the family *phytoptidæ*, or gall Mites, a group of insects which includes also in its ranks the well-known Red Spider of our gardens and conservatories.

"On examining a pear leaf," as Mr. Crawford* remarks, "that has been attacked some little time, a number of brown blister-looking spots will be seen. These are at first nearly round, but as they grow in size they spread laterally, generally taking the direction of the venation of the leaf. These are galls, for there is a decided thickening of the inside portion of the leaf, and each of these contains a greater or less number of these Mites (see Plate XIV., Fig. 2), which have been magnified and drawn from nature. As the *phytopti* suck away the juices of the leaf, or otherwise destroy the cellular tissue, it turns brown, and finally nearly black, but beyond stimulating the tissue so that it is developed abnormally, as in the case of all gall-producing insects, it does not appear to do further injury. As the galls enlarge, owing to the food requirements of the population within, they often coalesce, so that in time the greater portion of the leaf becomes a blackish scab, containing probably one thousand *phytopti*."

* Report on the Fusicladiums, p. 46.

This Mite, even when full grown (see Plate XIV., Fig. 2), is so small that it is next to invisible without the aid of a lens, is, as the magnified drawing shows, a most curious looking creature, and I should say well deserves its title to be considered an entomological puzzle; and Murray, in quoting from Kallenbach, tells us that according to Kirchner, "The Mites live on the small yellow shining leaves, where they cause red swollen places, which later on become dark-red and black. On the underside of the leaf a small hole can be seen with a lens, in each of the swellings through which the old Mites go in and out (see Plate XIV., Fig. 5). [Any of our readers can, with a fairly powerful lens, observe these interesting but destructive little insects for themselves.—C. F.] When one cuts through one of these swellings horizontally (see Plate XIV., Fig. 4), the cellular tissue seems to be loosened, yellow and blackish, and between and under the loosened parts are found the eggs and Mites."

How long this enemy of the pear has been known to Victorian orchardists I am not aware, and Mr. Crawford tells us that public attention in South Australia was first called to the *phytoptus pyri* by Sir R. D. Ross, in April, 1881. I fancy, however, that in Victoria this little insect must be classed amongst the more recently imported pests, and so curious are they in their structure and economy that, according to Murray, "Some botanists jumped to the conclusion that they were cryptogamic growths. This idea once received, botanists took them under their charge and described the various kinds under the name of *erineum*, &c. Subsequent discoveries, however, have shown that these species of *erinium*, in almost every case, are growths or products caused by some species of the small Mite which we have now under consideration; a Mite so small and sometimes so crystalline and transparent (as in the *phytoptus* of the ash, for example) that it cannot be seen in the gall at all, and it is only by washing out the galls and searching for them in the water in which they have been washed that it can

be seen that there has been a living creature there at all. The first step towards a knowledge of this was made nearly a hundred and fifty years ago by Reaumur, the celebrated French entomologist."

Fortunately for us in Victoria, there is, I believe, no authentic record of the presence of any of the bud-destroying *phytopti*, which, according to all accounts, are much more to be dreaded than those attacking the leaves only. So far as can be ascertained, as quoted by Murray, there are four species named and described as living in buds, and 46 that prey upon leaves, these latter insects being again subdivided into various genera, and as in *tetranychus*, or Red Spider, these bear the generic names of the various plants on which they feed, as *pruni*, for the plum; *mali*, for the apple; *vitis*, for the vine, and so on.

With regard to the life-history of these singular little animals, Mr. Crawford gives it as his opinion, "That there are two ways in which the Mite survives the winter when all the leaves are shed; first, by hybernating among the hairs of and in the leaf-bud, and secondly, by forming colonies under the tender bark of the last year's growth, as I have found them in both situations. It may be the eggs are laid in the buds, as very young leaves, when still unfolding, have often very small galls, which are then of a pink colour. I expect, therefore, that the majority of the Mites quit the leaves on the approach of their fall, to take up their winter quarters in these places. The Mites that fall with the leaves would soon die, but their eggs might be blown about with the decayed leaves, and by chance alighting on the pear trees, colonize them. The wind, birds, and insects are, doubtless, the principal means of disseminating this pest in the summer time. The number of living *phytopti* on an ordinary-sized pear tree that is badly attacked must amount to several thousands, if not millions; so that, allowing for a most lavish waste of life, the chances of a few being carried to other pears in the neighbourhood must be considerable."

Here we have the practical experience of a gentleman who has done so much in a very unostentatious manner

for the fruit-growers and farming industry of South Australia, and whose loss we all must deplore.

As to the habits of this particular *phytoptus*, these useful hints should enable us to deal promptly and effectually with this and similar insect pests.

Prevention and Remedies.

I quite agree with the late Mr. Crawford and others, who recommend the use of kerosene emulsion, proportion, say 1 to 14; caustic soda, 4, 8, and 12 ounces to the gallon; and sulphuretted lime, of the strength made according to the receipt, and the same diluted with one-half and one equal quantity of water. Mr. Crawford also recommends these to be used in three washes as an experiment, but which as yet I have had no opportunity of testing for myself.

According to Hubbard's experiments with insecticides on the *phytoptus* of the orange, which is very troublesome in Florida, in the Southern States of the American Republic (and which insect may in all probability appear here in Victoria), the kerosene emulsion, 1 to 14, killed the living mites, but not the eggs; two pounds of caustic potash to a gallon of water killed both mites and eggs, and charred the leaves; but the best results were obtained by whale-oil soap. Soft soap, our nearest substitute, with perhaps the addition of sulphur, say 1 lb. to 5 gallons of water, might be tried as a summer wash, to be repeated two or three times at intervals of one week; a kerosene emulsion of 1 to 20, and 1 to 40 might, Mr. Crawford thinks, be tried.

Winter spraying should never be neglected, as it is of the greatest importance, and more especially, as has been previously remarked, should it be used against the resting spores of micro-fungi, with which a large number of our fruit trees, vines, cereals, &c., are affected.

As a precaution, the falling leaves of the pear trees should be raked up and burned, so as to prevent, as far as possible, the insects from accumulating. Sulphate of potassium, in the proportion of say half-an-ounce to the gallon

of water, has been highly recommended as a sure remedy against Aphidæ and Plant Lice, and might with advantage be tried on all soft-bodied insects, whether large or small, and "Magic soap," if used in the proportion of say 1 lb. to 8 gallons of water, has been proved to be a cheap, sure, and effective remedy against the much-dreaded Peach Aphis, as also similar insects.

For certain kinds of insects, as Red-Scale, Cottony-cushion Scale, and others, which are difficult of eradication, the canvas covering for the trees, mentioned by Mr. West, irrigation expert, as being largely in use in America, and under which the trees can be thoroughly treated with gas, &c., would, in my opinion, be very useful also for the *phytopti* and other minute insects. [An illustration of these covers are given elsewhere.]

In spraying trees against *phytopti*, care should be taken that the liquid used is projected upwards, as the galls containing the insects are to be found on the under side of the leaves, so that the falling of the "mist," if sprayed in the usual manner as for Aphis, &c., would, no doubt, fail to reach either the insect or their habitations.

With regard to the spraying of the trees against the attacks of *icerya*, and other insects difficult of destruction, Professor MacOwan, of Cape Town, wisely states, "It is next to useless to spray the trees from the outside; the labourer, dressed in a sack, with holes for the head and arms, should get up *inside* the spread of the tree, if it be large, and swish the back of the leaves, *i.e.*, take the enemy in the rear."

Professor MacOwan, as also Mr. W. G. Klee, inspector of fruit trees, California, thinks that the soapy solution (referred to elsewhere) has a better effect when applied hot, *i.e.*, as warm as the hand can bear it, than when cold, opinions which have been borne out by the results of many experiments both in America, Europe, as also in the colonies.

CHAPTER XX.

TABULATED LIST OF THE PRINCIPAL MATERIALS IN USE FOR THE DESTRUCTION OF NOXIOUS INSECTS, ADAPTED FROM MASKELL, WITH PERSONAL OBSERVATIONS.

1. ALCOHOL (SPIRITS OF WINE, &c.).—Will kill most soft-bodied insects, but sprayed over scale produced no apparent effect.—*Comstock.* Tried against Rutherglen bug pest, but failed to kill the insect. Is also too expensive for general use.—*C. F.*

2. AMMONIA.—Whether used pure (diluted) or in wine damages the plant much more than it does the insect.—*Hubbard, Comstock.*

3. ASHES.—Ashes, powdered or mixed with lime, salt, soot, &c., of no use whatever.—*Hubbard.* I have seen wood ashes used with good effect on peach aphis and pear slug.—*C. F.*

4. BENZOLE.—A valuable and well-tried remedy against insects attacking ripe or ripening fruit, as grapes, cherries, &c., as it will kill almost any insect by contact; no perceptible flavour of the benzole being noticeable on the fruit. Must be kept well stirred, and used with a very fine spray pump and nozzle; should not be used on young and tender foliage of fruit trees of any kind.—*C. F.*

5. CARBOLIC ACID.—Of no avail, either as spray or brushed on, unless used in such strength as to seriously injure the tree.—*Hubbard, Riley, Comstock.* A weak solution is very good for use against the elm-borer and peach-borer, also for the preservation of cabinet specimens of insects, and against clothes moths.—*C. F.*

6. CARBON BI-SULPHIDE.—A very useful material, but very combustive and offensive to those who use it. It is especially valuable in destroying the white ants at roots of vines and the citrus family; but as it evaporates very quickly, Quibell's Mixture was found to be more suitable as being more lasting in its character. Bi-sulphide has

been tried with varying success against phylloxera, and were it more lasting in its nature, it is difficult to understand the cause of even a partial failure. For the preservation of furs, seed grain, &c., nothing is so cheap and effective as bi-sulphide of carbon; and if the articles to be treated are placed in a comparatively air-tight tin box, no living thing can withstand its effects. The use of bi-sulphide in covered close quarters is said to produce insanity and other diseases, but with due care and a proper regard to ventilation, there is, I think, little danger to be apprehended from its use. Against ants and ant-hills bore holes in the hills, pour bi-sulphide into the holes and cover quickly, when every ant, eggs and all which are in the formicarium, will be destroyed.—*C. F.*

7. Castor Oil.—Has been found efficacious in cleaning Hawthorn trees at the Agricultural College, Lincoln, N.Z.—*T. Kirk.* It was mixed with soot, for some unexplained reason. It is doubtless a valuable remedy, but as an insect destroyer it is too expensive for general use. Castor oil plants if grown on waste lands in Northern districts would be a great destroyer of grasshoppers and locusts of all kinds, and if largely distributed may yet become a payable article of commerce. The common type of *Ricinus communis* is the hardiest and best for the purpose.—*C. F.*

8. Coal Tar.—A valuable remedy, and if mixed with a large proportion of water, say 1 lb. to 100 gallons; has been tried very successfully for caterpillars on cabbage-plants, also for slugs, snails, wood-lice, &c.—*C. F.*

9. Eucalyptus Oil (crude).—This has been prepared by Mr. Bosisto, C.M.G., of Melbourne, and tested by him and Mr. Geo. Neilson, Curator of the Royal Horticultural Society's Gardens, Richmond. Mr. Neilson speaks very highly of its efficacy, but advises that it be used with caution.—*C. F.*

10. Gishurst Compound.—An old and well-tried remedy, largely used by gardeners and others in England and elsewhere, and has of late been used with much success against the aphis on peach.—*C. F.*

11. Hellebore Powder (poisonous).—Largely in use against many insects, as pear-slug, turnip-fly, &c. Might be tried against Rutherglen bug-pest, thrips, &c.—*C. F.*

12. Kersoene.—Seemingly the most valuable of all remedies, when properly applied. Almost the only substance which will certainly kill the eggs without destroying the plant.—*Hubbard.* An excellent mixture if milk can be obtained cheap.—*Riley*, *Hubbard*, *Comstock.* Sour milk for making the emulsion is as useful as fresh.—*Maskell.* Mixed with castor-oil, linseed-oil, and whale oil, may be used in the proportion of one part kerosene to three or four of oil, and this has been found to be very efficacious for apple and other fruit trees attacked by apple-scale (*Mytilaspis pomorum*), but the mixture must not be laid on too thick. Thinly brushed all over trunk and branches at dead of winter, it has been found quite successful in destroying both insects and eggs, without injury to the trees.—*Maskell*, *Personal Experiments.* Also used in the bush to prevent ants crawling up legs of meat-safes, &c.—*C. F.* In America calico saturated with kerosene, and stretched across bars or upright frames, has been used very successfully in destroying locusts whilst on the wing.—*American reports.*

13. Lime.—Slaked lime, if dusted on the foliage of pear trees affected with the pear slug (*Selandria*), is a very effectual remedy, and unslaked lime, as a preventative and destroyer of garden snails, slugs, and wood-lice, has few equals for general efficacy.—*C. F.*

14. Gas Lime.—Has been used very successfully on soil affected by aphis, plant bugs, &c.; also useful against the black slug, snails, &c.—*C. F.*

15. London Purple (poisonous).—According to Professor Riley and other entomologists of note, both in America and elsewhere, this is the best of all remedies against the codlin moth. For fuller particulars see Codlin Moth, page 51.—*C. F.*

16. Lye.—Sometimes spoken highly of in America, but not in use here, and according to reports it is inferior to kerosene in killing power, and far more injurious to trees

when used in solution strong enough to be effective as insecticides.—*Maskell.*

17. Paris Green (poisonous).—Said to be largely used in America against codlin moth, &c. Requires to be used with great care.—*C. F.*

18. Pyrethrum (Persian Insect Powder).—A very useful preparation, the best being obtained from *P. cinerae folium.* This insect powder is of more use in small gardens and dwelling houses than in general orchards or farm work, as it is as yet too expensive to be used extensively.—*C. F.*

19. Quibell's Insecticide.—Has been tried here on many occasions. Of great value in treating roots of vines, orange, and lemon trees against attack of white ants, &c.; also for certain kinds of soft-bodied insects, as woolly aphis, mealy bug, &c., and when in strong solution will kill scale, &c.—*C. F.*

20. Resin Compound.—A most valuable remedy against scale and other insects not easily destroyed by the ordinary insecticides. This compound comes to us from America, where it has been successfully used under the supervision of Professor Riley, Mr. Koebele, and others. Mr. Koebele speaks of it as being the most efficacious of all remedies against scale insects. It has proved very successful in Victoria also. The preparations are given on page 41.—*C. F.*

21. Salt.—Of not much use against ordinary insects, but against slugs and snails it is very efficacious, and, as a rule, should be used sparingly, for if used in large quantities it is very injurious to crops.—*C. F.*

22. Soap.—Undoubtedly a valuable remedy, and, perhaps, in some cases, as efficient as kerosene ; but it does not kill the eggs.—*Maskell.* Of soaps there are many kinds—a soft soap, an old and very trustworthy remedy against plant lice, mealy bug, &c.

23. Burford's Kerosene Soap.—This has been tried with much success in South Australia, and I should have no hesitation in recommending its use in our colony.—*C. F.*

24. Clack's Insect Soap.—I have not had sufficient experience with this soap as yet, but should judge it to be somewhat similar to the Norris Soap. Further experiments may, however, prove its worth or otherwise.—*C. F.*

25. Magic Soap.—This soap, a new invention, has been tried with success upon the peach aphis; proportion, 1 lb. to 8 gallons of water, and sprayed on to the tree whilst hot. In spraying the young shoots of any kind (but peaches especially) great care must be taken that the material used is not hot or strong, otherwise the leaves shrivel and turn black.—*C. F.*

26. Norris' Insect Soap.—The results obtained from the use of this soap were something similar to those of the former (Magic Soap).—*C. F.*

27. Soda Caustic.—Strongly recommended by many persons. It injures the tree, but does not kill the eggs.—*Maskell.* If used with resin and fish-oil, very efficacious in dealing with scale and other insects.—*C. F.*

28. Soda (Silicate).—Kills some insects, but injures the tree.—*Hubbard.*

29. Sulphate of Iron.—A common ingredient of impotent remedies, most injurious to vegetation.—*Hubbard.* If used in weak solution it is perfectly safe, and for many insects—particularly those below ground—it is an invaluable remedy.—*C. F.*

30. Sulphur.—One of the oldest and most valuable of insecticides and fungicides at present in use. Of great value against red spider, phytoptus, &c., and has recently been successfully tried for the purpose of preventing winged locusts from settling upon and destroying fruit trees. Of no use against scale and like hardy insects. The lump sulphur, if crushed, is better for use than the ordinary "flowers of sulphur."—*C. F.*

31. Tobacco.—An invaluable indoor remedy against aphis, thrips, &c., also, if strong, on mealy bug. It can be used either in solution or for fumigation, the latter mostly for plants growing under glass. Can be obtained cheaply from any wholesale tobacco merchant or from factories.—*C. F.*

APPENDICES.

ILLUSTRATIONS OF SPRAY PUMPS AND OTHER MACHINES IN USE FOR THE DESTRUCTION OF INSECTS.

The object of including in Part I. of the Handbook illustrations of the various spraying pumps and other insect-destroying machines now in use either here or in America is that farmers, fruit-growers, vignerons, and others may be able, by aid of figures and descriptions, to select for themselves such articles as appear best suited for their requirements; and as our rural population is in some districts scattered and so far removed from the great centres of population, I have thought it advisable to furnish some particulars as to cost, &c., as also the names and addresses of firms from whom the machines may be obtained, taking them in the order in which I have received the particulars from the owners or their agents; the author of each article or description being responsible for the statements contained therein.

APPENDIX I.

SPRAY PUMPS, ETC.

Knowles' Improved Spray Garden Pump.

(*See Fig.* 1.)

Description: Fixed in a strong galvanized pail of any capacity is a brass cylindrical tube, which contains the plunger and piston; at its base is a tripod of cast brass, in the centre of which is a ball-valve, which gives ingress but not egress to the liquid to be ejected. This is surrounded by a larger cylinder of brass, which has in its lower end a flat valve connecting it with the inner cylinder, and on the outside of the upper end is fixed a hose-pipe of indiarubber (which may be of any length), to which is attached "An improved spray distributor."

Action: The plunger being lifted by a stirrup-shaped handle fixed to the upper end of the piston-rod, the liquid is drawn out of the pail through the ball-valve into the inner cylinder. On the plunger being gently pressed downwards, the liquid, not being able to repass the ball-valve, is forced through the flat valve into the outer cylinder. This causes the air within to become highly compressed, and the liquid is driven out of the aperture at the top and through the delivery hose and spray distributor in the form of a fine mist. As a single lifting of the plunger draws as much liquid into the pump as can be discharged

through the improved spray distributor in half a minute, the force necessary for its ejection is very slight, the action being almost self-acting. The compressed air not only lifts the plunger and piston, but drives out the liquid at the same time. A boy of ten years can use it as well as a man.

Price: Complete, 60s.

Agents: Messrs. McLean Brothers and Rigg, Melbourne.

This pump can be supplied with a large nozzle, with three delivery, at 12s. 6d.; four delivery, 15s.; five delivery, 17s. 6d. extra; or with Charnwood spray, at 17s. 6d. extra.

The Charnwood Spray.

(See Fig. 2.)

Made by A. Cramer, 316 Post Office-place, Melbourne.

It throws a very fine mist-like spray, thus economizing the liquid used. It is very easily cleaned. It has a double plate, which is made fast by indiarubber washers; it is so constructed that by unscrewing the top a fine or coarse distribution can be attached as desired. The fine spray is called No. 1, and the coarse spray No. 2. Another advantage in saving of the liquid is a tap which can be immediately stopped when desired.

Price: With tap, 20s.; without tap, 17s. 6d. Extra for a new cover, No. 1 or 2, 10s. 6d.

Agents: Messrs McLean Brothers and Rigg.

Danks' Pump and Sprays.

(*See Figs.* 3 *and* 4.)

The illustrations here shown represent the style of pumps manufactured by Messrs. John Danks and Sons, Limited, with patent spray. The patent sprays are made according to the well-known law of centrifugal motion of water, which has the effect of breaking the solution used into a very fine dew or mist, which may be pumped on any plant of tender growth without in any way damaging the leaves, and effectually killing any insects however small or minute. The patent sprays are made from a single to a five spray cluster, and may be used with either of the pumps. They can be supplied with an extra long branch for spraying high trees. The pumps are strong and durable, and may be worked by any lad.

Prices:

	£	s.	d.
Danks' Spray Pump, fitted on tank, with patent single spray	5	0	0
Lever Spray Pump, with single cluster	2	0	0
Spray only, single	0	3	0
„ „ double	0	7	6
„ „ treble	0	10	6
„ 4 spray	0	15	0
„ 5 „	0	17	

Spawn's Climax Spray Pumps.

(*See Figs.* 5 *and* 6.)

Fig. 5 represents Spawn's Improved Spray Pump, and is arranged so that it can be drawn by one horse. The tanks each hold about 10 gallons. One tank is used as a mixing tank, and by opening the stop-cock between the two it is strained into the pumping tank.

Price: With 20 feet of hose, £7.

Fig. 6 represents Spawn's Spray Pump and Fire Engine combined.

Price: Equipped with 50 feet of hose, £11.

The tanks are made of galvanized iron, and the pumps of brass.

Makers: A. F. Spawn, Horsham.

The Triplet Cyclone Nozzle.

(*See Figs.* 7, 8, 9, 10, 11, *and* 12.)

This nozzle is the invention of the late Frazer S. Crawford, of Adelaide, who first introduced the cyclone nozzle to the notice of Australian fruit-growers. The triplet consists of three cyclone or Riley nozzles fixed together at such angles as to form the most efficient spray. The original triplet, as experimented with and described in the report on Fusicladiums, was made so that the nozzles could be placed at any desired angle, but those made by Mr. Dobbie, of Adelaide, and copied by New Zealand and other manufacturers, have the jets permanently fixed at these angles, that Mr. Crawford found best in practice. This gentleman has also improved on the original nozzle, as described by Barnard, by having the walls of the chamber made thicker, so as to allow of an indiarubber washer being used, and thereby much less screwing is required to make the cap fit watertight. The nozzle should be attached by at least 15 feet of hose to any good garden force-pump.

We have reproduced Figs. 7, 8, 9, 10, 11, and 12, from Mr. Crawford's *Report on the Fusicladiums*, 1886. In describing the above figures Mr. Crawford quoted from Mr. Hubbard's *Report on insects affecting the orange*, forwarded by the U.S. Department of Agriculture, as follows:—

"In dealing with an enemy so thoroughly protected as are many of the bark lice, liquid insecticides should be applied in as fine a spray as possible, or at least in moderately fine spray, driven with considerable force, in order to increase to the utmost their penetrating power. The aim should also be to reach and thoroughly wet every portion of an infested tree, so that no individual scale insect shall escape the action of the liquid. This result is not attainable by the old method of sending a jet from a distance into the tops of the trees. An ordinary garden syringe is practically useless. There is needed a force-pump and a nozzle, giving a finely atomized spray This nozzle should be

attached to a sufficient length of flexible hose to allow it to be introduced into the top of the tree. The orifice of the nozzle should be directed at a right angle to the hose, and not in line with it. The jet of spray may thus, by a turn of the wrist, be directed upward or downward, and brought into contact with all parts of the foliage and branches, from beneath as well as from the upper side.

"The Cyclone Nozzle (Fig. 7; 1 profile; 2 plan; 3 section).—A nozzle which answers the above conditions, and is easily attached to any force-pump by means of a rubber tube, is described in the report of the Entomologist (*Report of the Commissioner of Agriculture, U.S.A., for* 1881-2, p. 162). It consists of a shallow circular metal chamber, soldered to a short piece of metal tubing as an inlet. The inlet passage penetrates the wall of the chamber tangentially, admitting the fluid eccentrically, and causing it to rotate rapidly in the chamber. The outlet consists of a very small hole drilled in the exact centre of one face of the chamber. The orifice should not be larger than will admit the shaft of an ordinary pin. Through this outlet the fluid is driven perpendicularly to the plane of rotation in the chamber. Its whirling motion disperses it broadly from the orifice, and produces a very fine spray, which may be converted into a cloud of mist by increasing the pressure in the pump. The perforated face of the nozzle-chamber is removable for convenience in cleaning the orifice when it clogs. The diameter of the chamber inside need not exceed $\frac{1}{2}$-inch and its depth $\frac{1}{4}$-inch. A nozzle of these dimensions, attached to the aquapult pump, covers $1\frac{1}{2}$ square yards of surface at a distance of 4 or 5 feet from the orifice. The amount of dispersion depends somewhat upon the thickness of the perforated face of the chamber. The diameter of the cone of spray may be increased by counter sinking the exit hole and making its edges thin. Three-eighths inch gum tubing is sufficiently large to supply one or a gang of several nozzles; the tubing must be strengthened with one ply of cloth. In use the end of the hose is supported by being fastened to a light rod of wood, which forms a handle, by means of which the nozzle may be applied to all parts of the tree. For full-sized trees a rod long enough to reach nearly to their tops must be used. For this purpose a convenient device may be made by passing the small rubber hose through a hollow bamboo rod of the required length. A three-sixteenth brass tube inserted in a bamboo rod has also been used.

"Fig. 12 exhibits a complete outfit for treating orange groves with liquid insecticides, from a photograph taken during actual service in the field. This consists of a common pendulum pump inserted in a barrel and mounted upon a cart. The liquid is delivered through two lines of hose, each ending in a cyclone nozzle. The arrangement here shown permits the spraying of two rows of young trees at once, and thus effects a considerable saving in time. In the same figure is shown an aquapult pump fitted with a cyclone nozzle and a single length (12 feet) of $\frac{3}{8}$-inch hose. The pump is inserted in a pail, ready for use as a portable apparatus for one, or preferable for two men."

Mr. Crawford, continuing, explains as follows:—"Having had several of these nozzles made by Mr. Boettger, of Adelaide, I recommend the following modifications as advisable for reasons which either suggested themselves while experimenting with them, or proposed by Mr. Boettger for cheapening their manufacture:—The part *a* (figure 7) to consist of a solid brass rod about $1\frac{3}{4}$-inch long and $\frac{3}{8}$-inch diameter. Through this to be bored a hole, so that the inlet *k* is about $\frac{1}{10}$-inch diameter, so as to be tangential to the inside of the chamber when brazed thereon. The diameter of the inside of the chamber should not be more than $\frac{1}{32}$-inch, and its depth $\frac{11}{32}$-inch, while its walls should be at least $\frac{1}{8}$-inch thick, so so as to allow an indiarubber washer to rest on the top and prevent the screw-cap from leaking. The outlet *s* to be about $\frac{1}{20}$-inch in diameter, with the outer part bevelled off much more than shown in the figure, so as to enclose nearly an angle of 90°. The screw of cap *c* need not be carried down to the bottom, as shown in the engraving; a depth of $\frac{1}{5}$-inch, with an indiarubber washer, is sufficient to keep the top firm and free from leakage.

"In using this apparatus the orchardist is cautioned to have the solutions for spraying carefully strained through linen, muslin, or cheesecloth, or other similar material, as owing to the very small exit hole of the nozzle it is very easily choked. For the same reason the suction hose of the pump should have its entrance guarded with fine wire gauze."

Messrs. McLean Brothers and Rigg are the Melbourne agents.

The "Strawsonizer."

(*See Fig.* 13.)

This machine is a new kind of distributor for applying, by air-power, liquid or solid insectifuges, and for broadcasting all kinds of grain, seed, and chemical fertilizers. The material to be distributed should always be in a free and dry condition, so as to pass evenly over the feed roller.

We extract the following as a good description of the machine from the *Agricultural Gazette* (British) of May 20th, 1889. It is a description of certain trials made at Windsor, England :—

"Two machines were ready for trial, one fitted for distributing liquids, and the other for solids. The same machine will do all kinds of work, and the only reason for using two was to save the time that would otherwise have been occupied in changing the fittings. The machine is a light one for one horse, and is constructed in great part of wood, mounted on two iron wheels. The distributing power is obtained by a blast of air produced by a revolving fan, worked by the travelling wheels of the machine. As the material falls from the hopper, it is caught by a blast of air, and spread from the back of the machine. For solids a metal spreader is fixed, while liquids are sent through nozzles placed in different positions for various purposes.

"The first trial was intended to illustrate the spreading of a liquid insecticide over the ground, paraffin being used for the purpose at the rate

of two gallons per acre. The machine will spread as little as a gallon over an acre of land, if required. A fine spray of paraffin was spread to a width of about 20 feet as the machine travelled, and every square inch of land in that space was found to be sprinkled. Next, the other machine was set to work to sow barley broadcast, at the rate of three bushels to the acre. The corn was distributed with wonderful regularity over a tract 18 feet wide. A greater width could be covered, but the width named is considered most effective, and, as at this rate 30 to 40 acres can be got over in a day, the width is sufficient.

"The fourth trial was an illustration of the sprinkling of a hop garden, special nozzles having been fixed for directing the liquid properly. In this case a dense and fine spray was sent out from the level of the ground up to a height of about 20 feet on either side of the machine, and all present agreed that if the operation had been carried on between two rows of the tallest hops the vine would infallibly have been sprinkled all over from top to bottom.

"Salt was next spread in as regular a style as the barley had been, and the operation showed how well the machine can sow nitrate of soda and other manures.

"Lastly, fine-powdered lime was sent in a cloud with the wind over a great space of land, falling in a fine film upon the surface of the land. If young turnip plants attacked by the fly had been growing in the field, every one of them must have been dusted with lime. In this operation a great area of land could be limed in a very short space of time.

"Small hand-power machines are made for gardens, fruit plantations, coffee or tea plantations, and other purposes, as well as horse-power machines for farms. Special distributors are made for use in vineyards."

Agent:—I. G. Foster, West Melbourne.

French Portable Hand Spraying Machine.

(*See Fig.* 14.)

We have taken the following information (and re-produced Fig. 14) from the "Third Annual Report" of the Agricultural Adviser (Charles Whitehead, F.L.S.) to the British Board of Agriculture regarding a small hand machine, as follows:—"This is a little machine largely made use of in the French vineyards for applying washes to vine for mildew and insects. Machines made upon the same principles are extensively adopted in Italy. The liquid in the tank is forced through the jet by the *vendangeuse* moving the lever on her left hand, as shown in figure 14. It might be used on small holdings. In plantations where the bushes are closely set a number of them could be advantageously employed."

We have been shown a machine constructed on a somewhat similar plan to the above, with the exception that the force necessary to send the liquid through the nozzle is by means of compressed air; unfortunately the machine, which is the invention of Mr. François de

Castella, is not yet finished, consequently we are not able to give a drawing of it in this appendix. The machine, which is very simple in construction, promises to be exceedingly valuable, if only for the fact of the little labour required in working it.

Lowe and Park's Patent Steam and Chemical Vapour Insect and Fungi Exterminator.

(*See Fig.* 15.)

This machine consists of a boiler, to which is attached an amalgamating chamber and evaporator for the purpose of amalgamating the steam with sulphur vapours and other chemicals, and works as follows:—When the steam is generated in the boiler, and the pressure has reached 20 lbs. to the square inch, the steam is turned on at the stop-cock (upon the top of the boiler), it then passes through the steam-pipe to the generator and amalgamator, and there becomes amalgamated with the vapours or liquids, and then passes on through the flexible hose in the right form and preparation to do the work of cleaning the trees and destroying the pests.

The disinfectants and vapours are by this system forced by the pressure of steam to the very bottom of every hole and crack in the tree, and without any doubt reaches the bottom of the disease, thereby thoroughly destroying all insect life, together with any larvæ or eggs, which may be at the bottom of the said holes and cracks. It also penetrates the loose bark, which is the home of the dreaded codlin grub.

These machines are made in three sizes, viz.:—

No. 1 machine is suitable for a very large orchard, or for the use of a district; it has two hoses, and intended for two men to work together on the trees. Three men can move this machine about, and it will cost £50.

No. 2 machine is suitable for large orchards, and has one hose only. Two men can move it about; costs £35.

No. 3 machine is suitable for gentlemen's gardens and small orchards. One man can move it about; costs £25.

Agent: Mr. Samuel Lowe, 592 Collins-street, Melbourne.

The Greenhill Codlin-moth Lamp.

(*See Fig.* 16.)

This lamp is an invention for the destruction of the Codlin Moth and other insects. The top portion consists of a vessel containing oil. From this are suspended wires or threads, down which the oil trickles, falling into a receptacle underneath, also containing oil. In the centre of the wires or threads a light is placed, and this attracts the insects; but in making for the light they come in contact with the wires or threads, which disable the insects, and falling into the receptacle below they are destroyed, and can be removed when necessary. The lamp is fitted so that it can be suspended from the trees or on any fixture. The design

is exceedingly simple, there being nothing of an intricate character connected with it. Any description of oil can be used, but the thicker the better. It is claimed for this invention (which has been duly protected by the inventor) that it will preserve all orchards, where it is in use, from the attacks of those numerous tribes of insects that have been so destructive to all fruit-bearing trees, and, in many cases, so ruinous to their proprietors. The inventor has tested the lamp with excellent results.

The price of the lamp is ten shillings each.

John Greenhill, 41 Collins-street, Melbourne.

"Patent Agitator Spray Pump."

(*See Fig.* 20.)

The above pump is manufactured by Messrs. Wilkins and Field, of Wellington and Nelson, New Zealand. The principal points in the pump are :—1. The pump being simple in construction is not liable to get out of order. 2. By means of a cylinder at the top of the pump it throws a continual flow of water. 3. It is easily worked, and for spraying trees two or three pulls at the piston-rod will fill the chamber and keep the spray going half a minute. 4. If it should clog up with any thick material the operator can open up the valves by means of screws at A and B and take out the marbles. 5. This alone is a great saving of time and money, as many other pumps require to be unsoldered and taken to pieces. 6. The agitator, B, is one of the strong points of the pump ; it keeps Paris green, hellebore, benzole, and any other mixture in the bucket in a continuous boil, and allows no sediment to settle in the bottom of the bucket. 7. Each pump is fitted with a straight jet, which is an ordinary Bray's gas burner, and is just as effective as, and is used in the Nelson (N.Z.) district in preference to, the cyclone sprays.

The pumps are made in Nelson, New Zealand, in three qualities, and are numbered 1, 2, and 3. No. 1 are made of zinc, japanned ; No. 2 are all brass, with the exception of the piston-rod, which is zinc ; No. 3 are all brass. A piece of $\frac{3}{8}$ brass tubing with a gas jet at the top is usually sold with the pump. This screws on in place of rose, &c., and is used to reach into and around tall trees.

Price: £3 and upwards.

Agents at Melbourne: McLean Bros. and Rigg.

APPENDIX II.

The Gas Treatment of Scale Insects.

The following matter having reference to the gas treatment of scale insects, with explanations of Figs. 17, 18, and 19, has been extracted from the "*Report of the Entomologist, Charles V. Riley, M.A., Ph. D.*,

for the year 1887" (*Annual Report of the United States Department of Agriculture for the year* 1887). The Figures 17, 18, and 19 have been reproduced from the above report.

REPORT ON THE GAS TREATMENT FOR SCALE-INSECTS.

By D. W. Coquillett, Special Agent.

Los Angeles, Cal., 20th January, 1888.

Sir,—I have the honour to transmit herewith my report upon the gas treatment for scale-insects (*Coccidæ*).

Shortly after my reappointment last July as an agent of your division the supervisors of this county withdrew their offered reward of $1,000 for a perfect exterminator of the *Icerya*, and their reason for so doing is thus given by the *Los Angeles Herald*:—

"On Saturday last the board of supervisors decided to rescind the reward of $1,000 which they had offered for the discovery of a remedy which would exterminate the White Scale Bug and other pests injurious to fruit trees. They came to this decision for the reason that it is believed that Mr. Coquillett, the Government appointee, has, by his gas system, mastered the problem which has so long been a puzzle to all fruit-growers."

My experiments have been conducted in the orange groves of Mr. J. W. Wolfskill, of this city. Both Mr. Wolfskill and his foreman, Mr. Alexander Craw, have aided me much in my work, as has also Mr. W. G. McMullen, one of the members of the Los Angeles County Horticultural Commission.

Your own advice and frequent expressions of confidence have done much toward giving to my work whatever of merit it may possess.

Very respectfully,

D. W. Coquillett, Special Agent.

Prof. C. V. Riley, U. S. Entomologist.

The Gas Treatment of Scale-Insects.

The process of destroying insects on plants in hot-houses by fumigating with sulphur, tobacco, and various other noxious substances, has long been in vogue, but up to a recent date this mode of warfare against insect pests has not been extended to trees and plants growing in the open air. The earliest record I possess of any attempt of this kind is a copy of the specifications for a patent (No. 64667) granted to Mr. James Hatch, of Lynn, Mass., on the 14th of May, 1867. The following extracts from these specifications will sufficiently explain the method pursued by Mr. Hatch:—

"The invention relates particularly to the manner of effecting the destruction of insects known as Canker-worms, after their lodgment in trees and while consuming the foliage thereof. * * * I cover the entire head of the tree with a thin cloth of close texture, drawing the edges around the trunk, so as to envelop the branches in a sort of sack. Near the tree I have a furnace, over which is placed a pan containing tobacco, pepper, or other substances, the smoke from which will stupefy

or kill the worms; and from this pan I lead a pipe directly into the sack. Applying heat to the pan by a lamp or by fuel introduced into the furnace, the smoke generated from the tobacco or other substance in the pan is thrown into the sack and soon fills it, coming into contact with all the leaves, and either killing or instantly dislodging every worm and all other insects that may be in the tree."

This method of destroying insects on trees could not have been very widely adopted. Dr. A. S. Packard, who for several years held the office of entomologist to the Massachusetts State Board of Agriculture, writes me that he is not aware that this method has been practised in any part of the Atlantic States. I can find no reference to it, nor to any similar method having been used in any of the States east of the Rocky Mountains from the date of the Hatch patent up to the present time.

For several years past many attempts at destroying scale-insects with gases and fumes have been made in southern California. For this purpose the infested tree was inclosed in an air-tight tent, the lower part of which was either fastened around the trunk of the tree or allowed to fall upon the ground; in the latter case a small quantity of earth was thrown upon the lower part of it, to prevent the escape of the gas or smoke. The tent was then filled with the smoke or gas experimented with.

Among the first to make experiments of this kind were Messrs. J. W. Wolfskill and Alexander Craw, of Los Angeles; Mr. John Wheeler, of San Francisco; Hon. J. DeBarth Shorb, Col. J. R. Dobbins, and Mr. B. M. Lelong, of San Gabriel. The substance most commonly experimented with was the liquid bisulphide of carbon (CS_2), but this did not prove entirely satisfactory, owing to the time required for it to evaporate and become diffused in the tent.

Probably no person has spent more time and money in trying to discover some effectual method for destroying the scale-insects with gas than has Mr. J. W. Wolfskill, of Los Angeles. In a paper read at a meeting of fruit-growers, held in this city on the 7th of October, 1887, Mr. Alexander Craw gave an account of the experiments made by Mr. Wolfskill and himself, from which we extract the following:—

"Previous to the year 1884 we had only the Black Scale (*Lecanium oleæ*) to contend with in the Wolfskill orange groves, and these scales were easily kept in check by an application of whale-oil soap in the form of a spray; one application every two years was sufficient. In the fall of the year 1884 we found a few trees on the south side of the large grove infested with the Cottony Cushion-scale (*Icerya purchasi*); they became infested from an adjoining grove. We prepared for war, and soon had our spraying apparatus at work upon them. As we were in for extermination, we made a strong solution of the whale-oil soap—so strong it almost defoliated the trees—and upon examination it looked as if we had gotten rid of the *Icerya*. A short time afterward, however, we found that the trees were again infested, and we sprayed again, using as much as 50 gallons of the solution to each tree; but even with

all this care, some of the *Icerya* escaped and soon covered the trees again, spreading in a north-easterly direction through the grove. We then cut the trees back, letting the branches drop upon a large canvas and afterwards burning them ; we washed the stubs and trunks of the trees with the whale-oil soap solution, but even this severe treatment was not effective, so we concluded that spraying would not check this prolific creeping curse.

"Knowing the fatal effects of a high temperature upon the young of the Black Scale, Mr. Wolfskill suggested experimenting with heat ; accordingly he had a tent constructed, and also a sheet-iron stove that would send the heat into the tent. We put the tent over an orange tree, and raised the temperature to 128° Fahrenheit for over an hour ; this killed the Black Scales, but the *Icerya* seemed to enjoy the heat. The tree was injured, so we gave up dry heat. We next tried steam from a small steam-boiler ; this cooked the top of the tree, but upon the lower half the *Icerya* was as lively as ever. Our next experiment was with tobacco smoke ; this test lasted six hours, but had no effect upon the tree or scales. Sulphur fumes were also tried ; this bleached the foliage, but did not harm the *Icerya*; a heavier charge killed both the tree and the scales. Among other experiments made under the tent were : Concussion from gunpowder ; muriatic acid gas ; carbonic acid gas; liquid chloroform, and also the gaseous chloroform manufactured under the tent from chloride of lime and methylalcohol; arsenic, and other fumes and gases. We had very encouraging results from the liquid bisulphide of carbon ; when confined for ten, twenty, or thirty minutes, or even for one hour, no satisfactory results were obtained, but when it was confined three hours it killed all of the scales, which soon assumed a pale buff colour. The gas, being a very powerful solvent, also acted upon the eggs, and they were destroyed, while the trees were not injured ; in fact, a few weeks afterward they started into a vigorous growth. Our efforts were then directed towards evaporating the bisulphide quickly ; heat, steam-baths, agitation, circulating the air in the tent, exposing the bisulphide in shallow pans, and saturating sponges with it were tried, but without hurrying matters much.

"Prof. D. W. Coquillett was so well impressed with our method of treating trees that he decided to investigate the subject ; accordingly, in the month of September, 1886, he began experimenting in the Wolfskill orange grove, and soon discovered that hydrocyanic acid gas would kill the scales and their eggs, but it also injured the foliage of the tree. We then united our efforts to remedy this evil, but it was something that required very close observation. We found that by withholding the water and allowing the sulphuric acid to come in contact with the dry cyanide of potassium in a fine stream we could treat trees without injuring even a blossom, while the gas proved fatal to the Black Scale (*Lecanium oleæ*), Red Scale (*Aspidiotus aurantii*), and the San José Scale (*Aspidiotus perniciosus*) confined in it ten minutes, but the Cottony Cushion-scale (*Icerya purchasi*) and eggs required a confinement of nearly thirty minutes.

"We then perfected an apparatus for putting the tent on tall trees quickly. This occupied a great deal of time, but we finally succeeded so well that we could change the tent from one tree to the other in less than two minutes. Mr. A. B. Chapman and Mr. L. H. Titus, of San Gabriel, became impatient at the delay and requested Professor Hilgard, of the State University, to send them a chemist, and they would pay his expenses. In the month of April, 1887, Mr. F. W. Morse was delegated for this purpose, and he, too, finally discovered that hydrocyanic acid gas would kill the scales; but Professor Coquillett had made the same discovery over six months previously, so that the credit of this discovery belongs to this latter gentleman. Much credit is also due to Mr. J. W. Wolfskill for the great amount of time and money that he has devoted to this cause.

"Alexander Craw."

I am not aware that either of the other experimenters mentioned above have ever published the results of their experiments, nor have I been able to obtain any notes from them upon the subject.

Many years ago Dr. George Dimmock, one of the editors of *Psyche*, made a number of interesting experiments with pure gases on various insects, and his account of these experiments is given in the March-April number of that journal for 1877. The results obtained by him are briefly as follows:—

"Carbonic acid gas (carbon dioxide) did not prove fatal to beetles confined in it for one or two moments, but several sow-bugs (*Oniscus*) confined in it from twenty to thirty minutes never recovered. Mixed with oxygen in the proportion of three parts of the former to one of the latter, it did not prove fatal to a beetle confined in it three minutes. When mixed in the proportion of sixty-six parts of the carbonic acid gas to thirty-four parts of oxygen, it did not prove fatal to a beetle confined in it five minutes, nor to a wire-worm (*Elateridæ*) confined in it thirty minutes, and of several sow-bugs (*Oniscus*) confined in it fifty minutes, to some it proved fatal, while to others it did not.

"Carbonic oxide gas (carbon monoxide) did not prove fatal to beetles confined in it ten minutes, nor to butterflies confined in it thirty minutes.

"Hydrogen did not prove fatal to a beetle and butterfly confined in it five minutes.

"Oxygen did not prove fatal to a spider confined in it one hour, nor to a beetle confined in it for three days.

"Nitric oxide (NO) proved fatal to a beetle confined in it only fifteen seconds, while several sow-bugs (*Oniscus*) confined in it from forty to sixty seconds never recovered."

My own experiments with the nitric oxide mixed with air did not prove as successful as those made by Dr. Dimmock with the pure gas; in fact, the brown fuming tetroxide proved more fatal to the *Icerya* than did the colourless oxids.

I first began experimenting with gases in the month of September, 1886, and have since continued it at intervals up to the present time;

an account of these experiments will be found at the end of this report. Among the numerous gases tried none have given as good satisfaction as the hydrocyanic acid gas ; an account of the discovery of the effects of this gas is given in the paper by Mr. Craw, reproduced above, and need not be repeated here. Several of the other gases experimented with by me have not as yet been given sufficient trial to justify me in reporting either for or against their use as insecticides.

In the month of April, 1887, several of the fruit-growers of San Gabriel, who had become acquainted with the results that Mr. Wolfskill, Mr. Craw, and myself had obtained from the hydrocyanic acid gas, applied to Prof. E. W. Hilgard, of the California State University, at Berkeley, for a chemist to assist them in experimenting with various gases, and he delegated Mr. F. W. Morse. Mr. Morse experimented with about half a dozen different kinds of gases, but found none so effectual as the hydrocyanic acid gas, which I had used over six months previously. His report will be found in Bulletin No. 15, Division of Entomology of this department. He was the first to use an apparatus for agitating the air in the tent, but this idea appears to have originated with Professor Hilgard, who writes me that he instructed Mr. Morse to always agitate the air in the tent after introducing the gas.

In the months of September and October, 1886, Mr. Albert Koebele, one of the entomological agents of this department, made a few experiments with the liquid bisulphide of carbon, an account of which he gave in his report to Prof. C. V. Riley, published in the report of this department for the year 1886, page 569. The results of these experiments, however, especially those made under a tent, are so discrepant as to leave one in doubt as to the value of the bisulphide as an insecticide.

During the past season I have made several experiments with the liquid bisulphide, the main object being to devise some method whereby it could be evaporated more quickly than by merely exposing it to the air, but the results of these experiments were not entirely satisfactory. I next manufactured the bisulphide by passing the vapours of sulphur over red-hot charcoal and conducting the gaseous bisulphide into the tent ; but the numerous experiments I have made with the bisulphide thus produced indicate that it can never be successfully used for the destruction of insects on trees.

The Tent.—The tent used in enclosing the tree is of the usual circular form, with a conical or dome-shaped roof. It is usually made out of heavy bed-ticking, and is afterward thoroughly oiled with boiled linseed oil ; care should be exercised not to leave the tent folded or rolled up while still damp with the oil. A tent belonging to Mr. J. W. Wolfskill of this city had been recently oiled, and when nearly dry was rolled up and thrown upon the ground where the sun shone upon it ; this was in the forenoon, and when it was unrolled the next morning the greater part of it was found to be charred, as if by fire.

It would be desirable to use some kind of ready-prepared cloth for making the tent, but thus far no substitute for the oil-cloth has been

found. I have received samples of water-proof cloth from the United States Water-proof Fiber Company, of New York, but even the heaviest grade, although evidently water-proof, is far from being air-tight. A sample of twilled sheeting, prepared especially for this purpose, is much closer in its texture than the above, but is not air-tight; they offer to furnish it at about 10 cents per yard, the heavy bed-ticking referred to above costing in Los Angeles about 19 cents per yard.

I have also received samples of rubber cloth manufactured by the Boston Rubber Company, of Boston, Mass. Their lightest and cheapest grade is a thin black cloth, which they offer to furnish and make into tents of any desired size, and with the seams closed up; the price would be about 23 cents per yard. This grade might answer for small tents—those not more than 5 or 6 feet high—but it is not strong enough for large-sized tents. At my request the company manufactured a tent about 12 feet high from this grade of cloth, but found that it was not strong enough for the use I intended to make of it.

They also sent three other grades of rubber cloth manufactured by them, and costing from 50 to 65 cents per yard made into tents, but it is doubtful that either of these grades would be strong enough for making large-sized tents.

I have also received samples of rubber cloth from the Goodyear Rubber Company, of San Francisco. Their light gossamer cloth is evidently not strong enough for making large-sized tents; its price is about 60 cents per yard. Their black rubber sheeting is the best that I have seen for this purpose, but the price, 54 cents per yard, would doubtless prevent its being used for this purpose.

Apparatus for Operating the Tent.—Where small trees are to be operated upon a sheet might be used for the purpose of confining the gas; or the sheet could first be sewed in the form of a sack, which could be easily slipped over a small tree from above, the operator standing on the ground, or upon a step-ladder. For operating on large trees, however, a device of some kind must be used for putting the tent on the tree, and also for removing it again.

The Wolfskill Fumigator.—This apparatus was designed by Messrs. J. W. Wolfskill and Alexander Craw, of Los Angeles, and is the first that has been used with success upon the largest orange trees. A good idea of its appearance is given in Fig. 17.

This fumigator consists of a strong wooden frame mounted on a low waggon or truck; in the centre is a tall mast, the bottom of which rests upon the waggon reach, which is strengthened by iron braces attached to the side pieces of the frame. The mast is placed between two pieces of pine timber and a stout iron pin passes through these pieces and through the mast. The bottom of the mast is kept in place by two blocks of hard wood bolted to the reach on either side of the mast; their inner ends are concave, so as nearly to encompass the lower end of the mast. For staying the mast, four iron rods are attached at one end to the four corners of the frame on the waggon, while their upper ends are attached to an iron clamp which encircles the mast a little above the middle of the latter.

A short distance above this clamp is an arm or boom and its triangular brace, bolted together so as to encompass the mast; at either end of this arm is a frame carrying one main roller and two side rollers, the latter being placed at a distance of about 6 inches from either end of the main roller, and their office is to prevent the tent from passing off of the ends of the main roller while it is being drawn over the latter. For the support of these rollers and the triangular brace, iron rods are attached to the top of the mast and pass to either end of each of the roller frames, and also to each outer corner of the triangular brace, while two other iron rods are fastened at one end to each outer corner of this brace, their other ends being fastened to one of the wooden side-pieces of the frame on the waggon. An iron rod also passes from each outer corner of the triangular brace to either end of the roller frame at the outer end of the arm to prevent side motion.

The tent is drawn off of the tree by means of a rope that passes through the two main rollers and down the mast to a windlass attached to the frame of the waggon, extending from one side piece to the other, and passing just behind the mast; by turning this windlass the tent is drawn off of the tree, passing over the main roller at the outer end of the arm, then over the one at the opposite end, and down the mast till the bottom of the tent has been elevated above the tops of the highest branches of the tree. At the bottom of the tent is fastened a circle of gas-pipe, for the purpose of keeping the bottom of the tent spread out while it is passing down over the tree; iron or steel rods made into a circle would be preferable to the gas-pipe, which is liable to break at the joints or couplings. To this circle are attached two or three ropes, to be used in pulling the tent down over the tree. The main rollers at either end of the arm are provided with a deeply-grooved pulley in the centre of each, over which the rope passes in drawing the tent off of the tree, or allowing it to pass down over one.

When it is desired to transport this fumigator to a considerable distance the mast is lowered by means of a derrick composed of four pieces of pine timber; the lower ends of the foremost pieces are attached to the front corners of the frame on the waggon, while the ends of the other two pieces simply rest upon that frame on either side of the mast. The upper ends of these pieces are fastened together by a strong iron bolt to which a large pulley is attached. In lowering the mast a large rope is attached to it just above the point where the iron clamp encircles it; the other end of the rope is then passed through the pulley at the upper end of the derrick, and from this point it passes to the windlass, upon which the rope is then wound. The block of wood bolted to the waggon-reach in front of the mast is then removed, and the stay-rods fastened to the frame on the waggon are disconnected; then, by unwinding the windlass the mast is lowered until it rests horizontally upon the waggon, turning upon the iron pin that passss through the mast near its base.

I have used this fumigator repeatedly, and it has given good satisfaction when used on level ground and at a time when the wind was not blowing very hard. Two men can operate it with ease. For transporting

from place to place it is the best apparatus that has yet been produced. It is desired to have the stay-rods and windlass attached to a turn-table, so that the tent could be taken off one tree and put upon another without moving the waggon; by this arrangement three tents could be operated by the one apparatus without any loss of time. It might also be desirable to mount this apparatus upon runners, like those of a sled, but placed as wide apart as the trees would admit.

This fumigator has not been patented up to date.

The Titus Fumigator.—This apparatus was devised by Mr. L. H. Titus, of San Gabriel, and is especially designed for operating on tall trees. It is shown in Fig. 18., and consists of four corner posts made by bolting together two boards in such a manner that they form a right angle with each other; at the upper ends these posts are connected by cross-pieces formed of boards bolted together like those forming the corner posts. Two of these cross-pieces are longer than the other two, and are placed on opposite sides of the frame; they are connected near the middle by two cross-pieces, between which is placed the roller upon which the tent is to be wound when being drawn off the tree. These various cross-pieces are braced.

The lower end of each of the rear corner posts is rigidly attached to an axle, on the outer end of which a light wheel is placed, while the inner end is connected with the corner post by an oblique brace. The lower end of each of the front corner posts is attached to the middle of an axle having a light wheel at each end; the post is attached to the axle by an iron bolt which permits the wheels to be at the same moment turned, the one forward and the other backward, like the forward wheels of a waggon or buggy. By means of this arrangement the fumigator can be turned about in a circle. The front and rear corner posts on each side of the fumigator are connected with each other by a cross-piece extending from one to the other, and strengthened by braces which extend obliquely from the cross-piece to the posts. When this fumigator is in use the front and rear cross-pieces shown in Fig. 18., as extending from the posts on the one side to those on the other are removed, so as to permit the frame to pass either forward or backward over the trees.

The top of the tent is attached by three ropes to the roller, while to the lower edge of the tent are attached four ropes, placed at equal distances from each other; each of these ropes passes through a pulley attached to a frame near each upper corner, and the end of the rope is attached to the lower edge of the tent at the place where the opposite end of the same rope is attached. For winding the tent upon the roller an endless rope is used; this passes around a grooved wheel at one end of the roller and is carried through a pulley near the upper end of one of the rear corner posts; from this point it passes to and around a grooved wheel fastened to the cross-piece near the lower end of this post, and this grooved wheel is operated by a crank.

In taking a tent off of a tree, each of the corner ropes is pulled through its pulley, drawing the bottom of the tent upward, thus turning the tent

inside out; after the tent has been drawn up as far as possible, the crank operating the grooved wheel that works the endless rope is turned, winding the tent upon the roller until it has been entirely removed from the tree. The fumigator is thus drawn forward until the tent is brought directly over the second tree, when the ropes attached to the lower edge of the tent are loosened, permitting the tent to drop down over the tree, at the same time unwinding the tent from the roller, and continuing this until the tent rests upon the tree.

I have helped to operate a fumigator of this kind several times, and it gave very good satisfaction, especially the manner in which the tent was let down over the tree and taken off again. The frame of the fumigator should be so constructed as to admit of its being lowered when not in use, to prevent its being injured by high winds; three of these fumigators have, to my knowledge, been totally wrecked by high winds within the last three months. There is also need of some device by which one of these apparatuses could operate two or three tents.

I am not aware that this fumigator has as yet been patented, although I am of the opinion that the inventor has applied for letters patent.

The Culver Fumigator.—This fumigator was devised by Mr. John P. Culver, of Los Angeles, who, on the 26th of July, 1887, obtained a patent on the same (No. 367134). While both the Wolfskill and the Titus fumigators allow the tent to pass down over the tree from *above*, the present one encloses the tree from one side, being made in the form of two half-tents, which encompass the tree and meet upon the opposite side. A very good idea of this fumigator can be gleaned from Fig. 19.

The frame-work of the tent may be constructed either of wood or of band iron, and the covering may be a light grade of tin, or a heavy grade of canvas, or of bed-ticking, well oiled with boiled linseed oil. The edges, which are to meet when the tent is closed, should be covered with a thick layer of felt.

The tent is transported from tree to tree upon a pair of runners, like those of a sled, fastened together by several cross-pieces, one of which is exactly in the middle, and near one end of this cross-piece is firmly attached an upright post, tall enough to reach a little above the lower edge of the roof of the tent; this post is further strengthened by two wooden braces attached to it near its upper end, their lower ends being attached to the runner on the opposite side of the sled. The two halves of the tent are attached to the post by means of four hinges, two of which are attached to the frame of the tent, near its lower edge and not far from the juncture of the two halves, while the other two are attached to the frame near the lower edge of the roof. The opposite ends of these hinges are attached to upright rods fastened to the post near its upper and its lower ends, and are so arranged as to allow the tent to be raised or lowered, independent of the post; they are so constructed that when the tent is being closed it is pushed forward until it is entirely clear of the sled, so that when the tent is closed it can be dropped upon the ground. The raising and lowering of the tent is accomplished by means of a lever applied to the frame of the tent near the point where one of the lower hinges is attached.

In taking the tent off of the tree the tent is first raised up with the lever until its lower edge is above the upper side of the sled, after which the tent is opened and the two halves are swung around and allowed to rest upon the sled, as shown in Fig. 19. The sled is then drawn forward until the junction of the two halves of the tent is brought opposite to the middle of the second tree, when the tent is slightly raised by the lever and the two halves swung around until they enclose the tree, after which they are fastened together and dropped upon the ground. The hinges at the upper end of the upright post on the sled are so constructed as to allow the tent to lean either backward or forward, so that its lower edge may conform to the surface of the ground.

I have been able to make only a single test with a fumigator of this kind, and it gave very good satisfaction. I am of the opinion that this fumigator will prove to be both cheaper and easier to operate than either of those described above. There is still need of some device by which the same tent could be made smaller or larger, at the will of the operator, so that it may be made to conform to the size of the different trees. Mr. Culver, the inventor, informs me that he intends to use two of these fumigators, transmitting the gas from one tent to the other; but it is impossible at the present writing to say whether or not he will meet with success, as no tests of this kind have as yet been made. If successful, this method would reduce the cost of treating a tree at least one-half.*

The Gas.—Among the numerous gases which I have tried none have given such good results as the hydrocyanic acid gas; even arseniuretted hydrogen and sulphuretted hydrogen, which are so fatal to the higher animals when respired, fail to produce the same deadly effects upon the scale-insects that is produced by the hydrocyanic acid gas.

The latter, which generated in the usual manner, by acting with sulphuric acid upon potassium cyanide dissolved in water, is very destructive to the foliage of the trees confined to it. To remedy this, three methods are at present known, viz.:—The *dry cyanide* process, which consists of acting upon the dry potassium cyanide with sulphuric acid; the *dry gas* process, consisting of acting with sulphuric acid upon potassium cyanide dissolved in water and passing the gas through sulphuric acid; and the *cyanide and soda* process, which consists of mixing bicarbonate of soda with potassium cyanide dissolved in water and adding the mixture to sulphuric acid.

The Dry Cyanide Process.—In my early experiments with this gas it was plainly to be seen that the less water the cyanide has been dissolved in the less injurious was the effect of the gas upon the tree confined in it. The heat generated in the production of the gas is sufficient to vaporize a considerable quantity of the water in which the cyanide has been dissolved, and this aqueous vapour collecting upon the leaves would condense the gas, which is very soluble in water, forming hydrocyanic acid, which is very destructive to plant life. It is also probable that the

* Mr. Coquillett writes later:—"The tent of the Culver fumigator is now made without a framework, except the two arches; this makes it both cheaper and lighter than before, permitting the tent to more nearly conform to the shape of the different trees confined in it."—C. V. R.

ascending vapour carried with it some of the unchanged cyanide solution, since it was clearly apparent that the gas was more injurious to the foliage when generated rapidly than when it was produced more slowly. Profiting by this discovery, I next tried acting with the acid upon the dry, finely pulverized cyanide, and the result proved that the gas thus produced was less injurious to the foliage than when generated in the usual way. It still injured the leaves to a certain extent, due, as it appears, to the fact that the ascending gas carried with it some of the fine particles of the cyanide and lodged them upon the leaves. My next step was to use the cyanide in large pieces instead of pulverizing it, and the gas thus produced did not injure the tenderest leaves of orange trees, even when confined in it for an hour. The proportion of ingredients used was about two fluid ounces of sulphuric acid to each ounce of the potassium cyanide.

Muriatic acid may be used instead of the sulphuric, but it is not as strong, besides costing more. Only the best grade of the cyanide, such as that commonly used by photographers, can be used for this purpose, since the cold acid will not act upon the poorest grade, which is commonly used for mining purposes ; and this remark is equally true in regard to both of the processes described below.

The Dry Gas Process.—I have already alluded above to the fact that the drier the gas the less injurious was the effect upon the tree confined in it ; and it occurred to me that the gas might be generated in the usual way, by acting with sulphuric acid upon potassium cyanide dissolved in water, and afterwards be dried by passing it through some medium that would deprive it of its moisture. Knowing the great avidity of sulphuric acid for moisture, I determined to use it as a drier for the gas, and several tests which I have made with this gas dried in this way proved that it does not injure the foliage of orange trees confined in it, while it is just as fatal to the scale insects as is the moist gas. The density of the acid through which the gas had passed was lowered about one degree, as indicated by the hydrometer ; but this would not prevent its use for generating the gas.

The cyanide is dissolved by boiling in water for a few minutes, using 1 gallon of water for each 5 lbs. of cyanide. It is desirable to use as little water as possible for this purpose, but the quantity could not be very much reduced from that given above. I have tried to dissolve 5 lbs. of the cyanide in half a gallon of water, but all of the cyanide had not dissolved after half-an-hour's boiling. For every ounce of the cyanide solution use half-an-ounce of sulphuric acid ; but it is always desirable to add some of the acid to the prescribed dose, in order that there may be an excess of the acid. No evil results will follow if double the proper quantity of the acid were to be used ; whereas if less than the proper quantity were used, the whole of the gas would not be evolved from the cyanide solution, hence the advisability of always using an excess of the acid.

In generating the gas the acid should flow upon the cyanide solution in a very fine stream. When they came in contact, violent action at

once takes place, and the gas is rapidly given off in the form of a dense whitish fog, resembling smoke and possessing a peculiar odour. When the gas, diluted with air, is inhaled, it produces a dryness in the mouth and throat.

It is impossible to give any definite rule for using the different ingredients that will apply to the differently sized trees, owing to the fact that trees of the same height may have a varying diameter of top ; thus orange trees 12 feet tall may have a diameter of top ranging all the way from 6 to 10 feet. The manner in which the tree is pruned will also make a difference in the quantity of the ingredients to be used, some trees being allowed to branch almost from the ground, while others are trimmed up from 3 to 5 feet from the ground.

The following table, based upon numerous experiments which I have made on orange trees under a tent 10 feet tall and having a transverse diameter of 10 feet, will give a good idea of the proper quantities of each ingredient to be used in treating citrus trees :—

Height (in feet).	Diameter (in feet).	Cyaniole solution (fluid ounces).	Sulphuric acid (fluid ounces).
6	5	2	1¼
10	10	12	7
12	8	9	
16	12	28	16
20	14	47	26

This table is based upon the cubical contents of the space enclosed by the tent, supposing that the lower part of the tent rests upon the ground. No harm will result to the tree if twice the quantity that I have recommended be used, but of course, for the sake of economy, it will be desirable to use only such quantity of each ingredient as will be necessary for destroying the scale insects infesting the tree to be treated with this gas. The sulphuric acid should have a density of 65° when tested with an acid hydrometer ; should its density be lower than this, use an extra ounce of the acid for every five degrees of density below 65°.

The Cyaniole and Soda Process.—The third method of rendering the hydrocyanic acid gas harmless to the foliage of the trees confined in it consists of mixing this gas with carbonic acid gas, the latter having the property of extacting the moisture from the former, forming gaseous carbonic acid. This appears to occur only under a certain degree of pressure ; thus, if the two gases are generated in the same open generator within the tent and allowed to rise and fill the tent, the hydrocyanic acid gas will prove nearly as injurious to the foliage of the tree confined in it as it would if no carbonic acid gas had been present.

The carbonic acid gas is produced by acting with sulphuric acid upon bicarbonate of soda or saleratus. The latter is first made into a thin paste with water, using about 1 fluid ounce of water to each 2 ounces by weight of the bicarbonate. Several seconds elapse after the sulphuric acid comes in contact with the soda paste before the evolution of the gas begins ; a foamy mass soon appears, consisting of variously-sized bubbles, which rise up in the generator and finally burst, giving forth the colourless and odourless gas. A fluid ounce of the acid will evolve all of the gas from about 3 ounces of the bicarbonate, weighed before it is mixed with the water.

The bicarbonate has a tendency to settle at the bottom of the solution, forming a compact mass upon which the acid acts very slowly. On this account it is desirable to add the soda paste to the acid instead of following the usual method of adding the acid to the soda. I have used marble dust in place of the bicarbonate of soda, and the result obtained by its use was as satisfactory as when the bicarbonate had been used ; it possesses none of the adhesiveness of the bicarbonate, and consequently does not form a compact mass in the bottom of the solution.

The best results have been obtained when both the hydrocyanic acid gas and the carbonic acid gas were produced in the same apartment of the generator.

The cyaniole is first dissolved in water, as described above, using 5 pounds of the cyaniole to each gallon of water, and for every 10 fluid ounces of this solution use 9 ounces by weight of the bicarbonate. The bicarbonate is first made into a thin paste with water, as above described, after which it is added to the proper quantity of the cyaniole solution and thoroughly stirred ; the whole is then added very slowly to the proper quantity of sulphuric acid, previously poured into the lower apartments of the generator.

The following table will give a good idea of the proper quantity of each ingredient to be used for the differently-sized trees :

Height (in feet).	Diameter (in feet).	Cyaniole solution (fluid ounces).	Bicarbonate of soda (ounces by weight).	Sulphuric acid (fluid ounces).
6	5	2	$1\frac{1}{5}$	$1\frac{3}{4}$
10	10	12	11	11
12	8	9	8	8
16	12	28	27	25
20	14	47	43	40

The hydrocyanic acid gas will be just as effective if twice the amount of the bicarbonate of soda that I have recommended be used, together with a sufficient quantity of sulphuric acid to evolve all of the carbonic acid gas from it. This latter gas does not act as a diluent, as some persons have supposed, but simply as a drier, its sole office being to extract the moisture from the hydrocyanic acid gas, thus rendering the latter gas harmless to the foliage of the trees confined in it.

The carbonic acid gas does not injure the foliage of orange trees confined in it; when sufficiently pure, it stupifies the scale insects confined in it for half an hour, but they wholly recover from the effects of the gas after the lapse of a few hours.

I noticed that when the trees were treated with the cyaniole and soda process in the hottest part of a very hot day the foliage was almost as severely injured as when the hydrocyanic acid gas had been used alone. We may conjecture that this results from the fact that at a high temperature the carbonic acid gas is freed from the aqueous vapour, leaving the latter in a proper condition for again uniting with the hydrocyanic acid gas. When these two gases are reduced to the liquid state by pressure or by great cold, it is found that the liquid carbonic acid gas boils at a much lower temperature than the liquid hydrocyanic acid does. A given quantity of water will dissolve about its own volume of carbonic acid gas, but all of this gas may afterwards be expelled by boiling.

Remarks.—Of the three processes described above, it is evident that the dry gas process is preferable to either of the others. Not only is there less labour in its manipulation, but it is also much cheaper than either of the other processes.

After the tree has been confined in the gas the proper length of time the tent should be entirely removed from it. On two different occasions I simply opened the tent to allow the gas to escape, after which the tent was again placed on the tree and the doorway of the tent left partially open; it remained on one of the trees for seven consecutive days, while on the other tree it was allowed to remain only for a day and night, but in both instances the trees were nearly killed.

The generator used in the production of the hydrocyanic gas is as shown in the foreground in Fig. 17, it was originally devised by Mr. Alexander Craw and myself, and has given perfect satisfaction.

This generator consists of two leaden vessels placed one above the other and connected by a brass stop-cock; to the end of the valve of this stop-cock is firmly soldered an L-shaped piece of an iron rod, to be used in opening and closing the stop-cock. The lower vessel is entirely closed above; near one side of the top is a screw-cap, covering the opening through which the proper chemicals are to be introduced into the vessel, while on the opposite side is an opening over which is firmly soldered the end of a leaden pipe, through which the gas passes on its way from the generator to the tent. When it is intended to pass the gas through sulphuric acid this leaden pipe is made to enter one side of an upright leaden vessel, and as near the bottom of the vessel as possible; to the top of the leaden vessel is attached a tin or leaden pipe which conducts the dried gas into the tent. Of course, if it is not desired to pass the gas through sulphuric acid, the leaden acid-vessel can be dispensed with, the leaden pipe from the generator passing directly into the tent.*

* Mr. Coquillett writes later as follows:—"In speaking of the gas generator I recommend passing the gas *through* sulphuric acid; a better way is to pass it *into* the acid, the leaden pipe which conducts the gas from the generator entering the upright leaden vessel above its middle, and curving downward in the vessel until the mouth of the pipe nearly reaches the bottom of the vessel and is covered by the acid."—C. V. R.

In charging the generator for the dry gas process, the proper quantity of the potassium-cyanide solution is poured into the lower vessel through the opening closed by the screw-cap, this cap having first been removed, to be again replaced after the solution has been poured in. The stop-cock connecting the two vessels of the generator is next closed by turning the handle attached to the valve, after which the proper quantity of sulphuric acid is poured into the upper vessel. The tin pipe attached to the upper end of the leaden acid-vessel is then removed, and a slightly larger quantity of sulphuric acid is poured into this vessel than was poured into the upper vessel of the generator; there should be a sufficient quantity of the acid in this leaden vessel to slightly more than cover the end of the leaden pipe leading from the generator. The tin pipe is next attached to the upper end of the acid-vessel, as shown in Fig. 17, while the other end of this pipe passes into the tent previously placed over a tree and made ready for the reception of the gas.

When everything is ready the handle of the stop-cock of the generator is turned until the acid in the upper vessel commences to flow into the lower one, where it comes in contact with the cyanide solution, and the production of the gas begins. The acid should be allowed to flow very slowly upon the cyanide solution; if the gas is produced too rapidly the acid will be thrown out of the acid-vessel; the latter should be taller than indicated in Fig. 17, and it would doubtless be an advantage to have it wider at the top than at the bottom.

After all of the gas has passed into the tent, the acid in the acid-vessel should be emptied into a glass or leaden vessel to be used the next time for generating the gas; for this purpose it would be well to insert a brass stop-cock in the lower part of the acid-vessel. There should also be quite a large stop-cock in the lower part of the lower vessel of the generator, for drawing off the residue before again charging the generator with fresh materials. When not in use the two vessels of the generator, and also the acid-vessel, should contain a small quantity of water, which will prevent the valves of the stop-cocks from becoming so corroded that they can not be operated without first being taken apart and cleaned.

Agitating the Air in the Tent.—After the gas has passed into the tent, and also while it is passing in, the air in the tent should be thoroughly agitated. The most effectual method of accomplishing this is by the use of some device whereby the air may be drawn out of the top of the tent and forced in at the bottom. When the McMullen or the Culver tent is used, the pipe taking the air out of the upper part of it can enter the top of the tent, but in the Wolfskill and the Titus tents both pipes must enter the tent at the bottom, the one intended for drawing the air out of the upper part of the tent passing some distance up the trunk of the tree, while the other pipe merely passes a short distance into the tent.

For circulating the air in the tent various devices have been used, but the one that has given the best satisfaction is known as the Cummin's blower, which was originally intended for forcing air into mines. It consists of an iron fan-wheel, driven with great velocity by means of a series of cog wheels and pinions, the whole encased in an

air-tight iron covering, having an opening on one side of the fan-wheel, through which the air is drawn out of the tent by means of a tin pipe, the base of which covers this opening. In the lower part of the fan-wheel chamber is a large opening, placed opposite to a similar opening in one side of an iron pipe closed at one end while to the other end is attached the tin pipe through which the air is to be forced into the tent. When the crank operating the fan-wheel is turned the air is drawn out of the tent through the tin pipe, and passes into the fan-wheel chamber through the hole in the side of the latter, and by the rapidly revolving fan-wheel is thrown by centrifugal force into the tent.

I had a blower constructed upon nearly the same principle as the above, except that the fans were made of tin, as was also the covering of the fan-wheel chamber, but it did not give very good satisfaction.

There is a machine manufactured at San José, Cal., and known as the Acme fumigator, which is provided with an iron fan-wheel driven by a belt. The blower of this fumigator is much too small to be used for agitating the air in the tent, but the manufacturer, Mr. A. R. Tomkin, informs me that they could be made of almost any size, and that the price would be less than a third of that of the Cummin's blower. This is a very simple arrangement, and if made large enough would doubtless answer the purpose quite as well as the Cummin's blower, and at a much lower price.

It has also been suggested to use a common blacksmith's bellows for the purpose of stirring the air in the tent, but it would appear to be a difficult task to manipulate it in such a way that the air would be drawn out of the tent as well as forced into it.

In the Culver tent a wooden fan is at present used, being placed inside of the tent; a fan of this kind, however, will always cause more or less trouble on account of its striking the branches of the tree inclosed by the tent. On this account it is advisable to always have the apparatus for agitating the air in the tent placed on the outside of the latter.

Whatever form of apparatus is used, it should be placed as near as possible to the point where the gas is to enter the tent; and if it can be so arranged that the gas can pass into the tent by the same pipe through which the air is forced into the tent, this will be a great advantage, since the gas will then become more thoroughly mixed with the air in the tent before reaching the foliage.

There are doubtless many valuable insecticides other than those in general use, and these will, if thought necessary, be included in Part II. of the Handbook.

The following table has been taken from the "Report on the Fusicladiums" (Crawford):—

USEFUL FIGURES TO BE REMEMBERED IN MAKING SOLUTIONS.

Gallon $\frac{1}{16}$ = $\frac{1}{2}$ pint.
„ $\frac{1}{8}$ = 1 pint.
„ $\frac{1}{4}$ = 2 pints, or 1 quart.
„ $\frac{1}{2}$ = 4 pints, or 2 quarts.
„ $\frac{3}{4}$ = 6 pints, or 3 quarts.
„ 1 = 8 pints, or 4 quarts.

1 fluid ounce of water weighs 1 ounce avoirdupois.
1 pint of water weighs $1\frac{1}{4}$ lbs.
20 fluid ounces make 1 pint.
12 fluid ounces of kerosene weigh 8 oz.
20 fluid ounces of kerosene, or 1 pint, weigh $13\frac{1}{2}$ oz.
1 pound weight of kerosene measures $1\frac{1}{5}$ pint.



Fig. 1.—KNOWLES' PUMP.

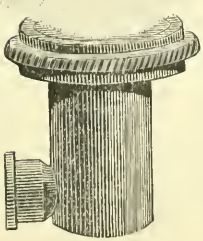


Fig. 2. CHARNWOOD SPRAY.

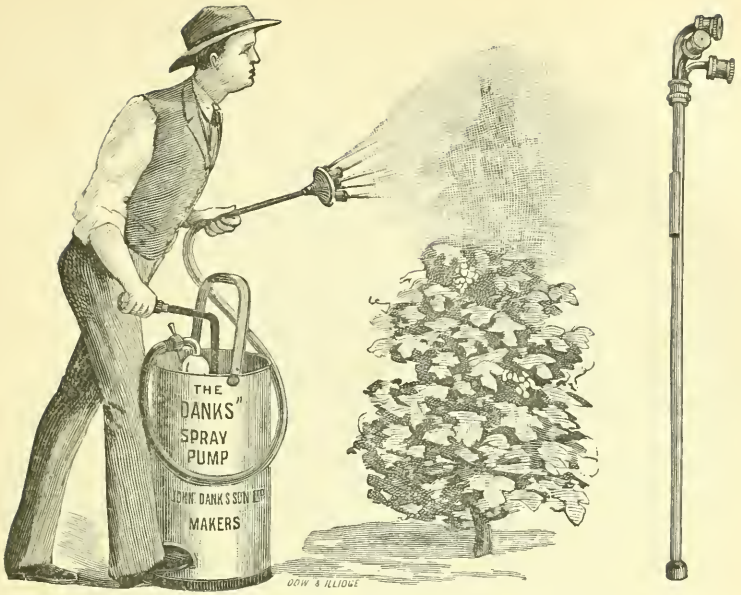


Fig 3.—DANKS' LEVER SPRAY PUMP, FITTED ON TANK.

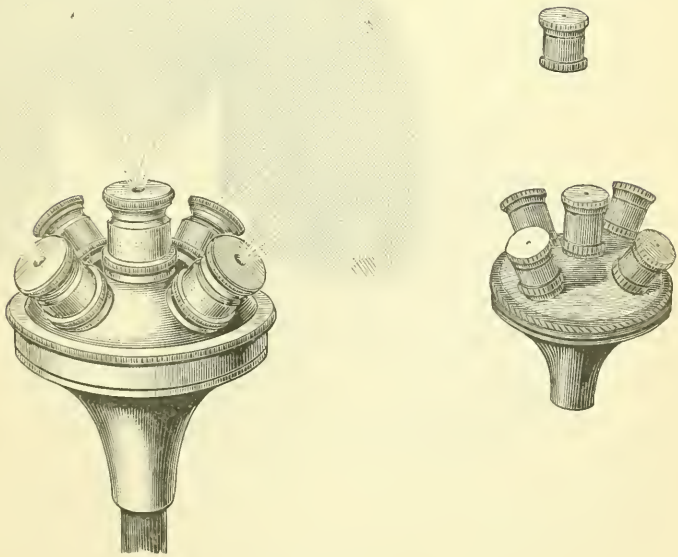


Fig. 4.—DANKS' SPRAYS.

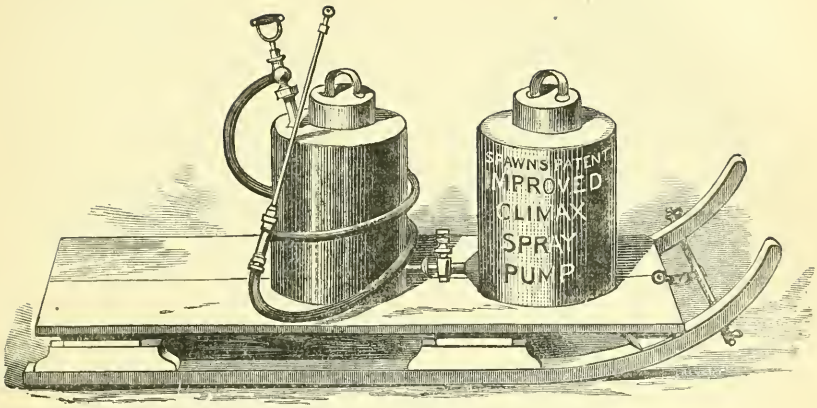


Fig. 5.—SPAWN'S No. 3 CLIMAX SPRAY PUMP.

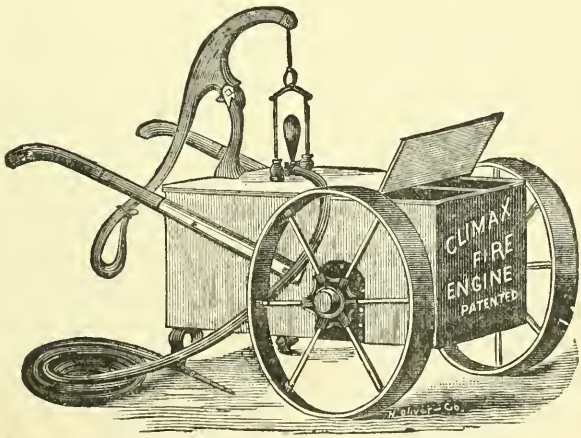


Fig. 6.—SPAWN'S No. 2 SPRAY PUMP.

Fig. 9.—Triplet Nozzle, quarter size.



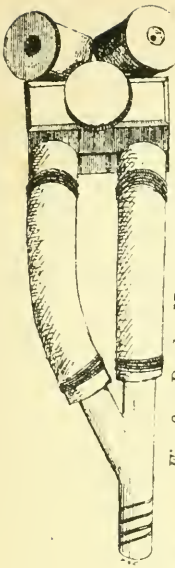


Fig. 8.—Duplex Nozzle, half size.

Fig. 10.—Showing Triplet Cyclone Nozzle in use.

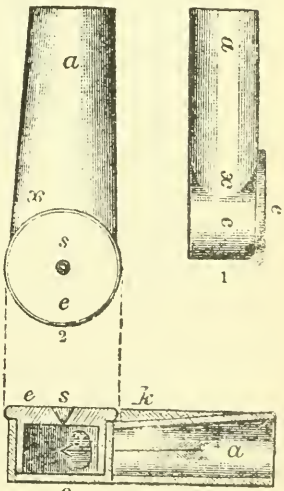


Fig. 7.—Cyclone Nozzle.



Fig. 11.—Aquapult Pump.

Figs. 7 to 10.—THE CYCLONE NOZZLE.

Fig. 11.—THE AQUAPULT PUMP.

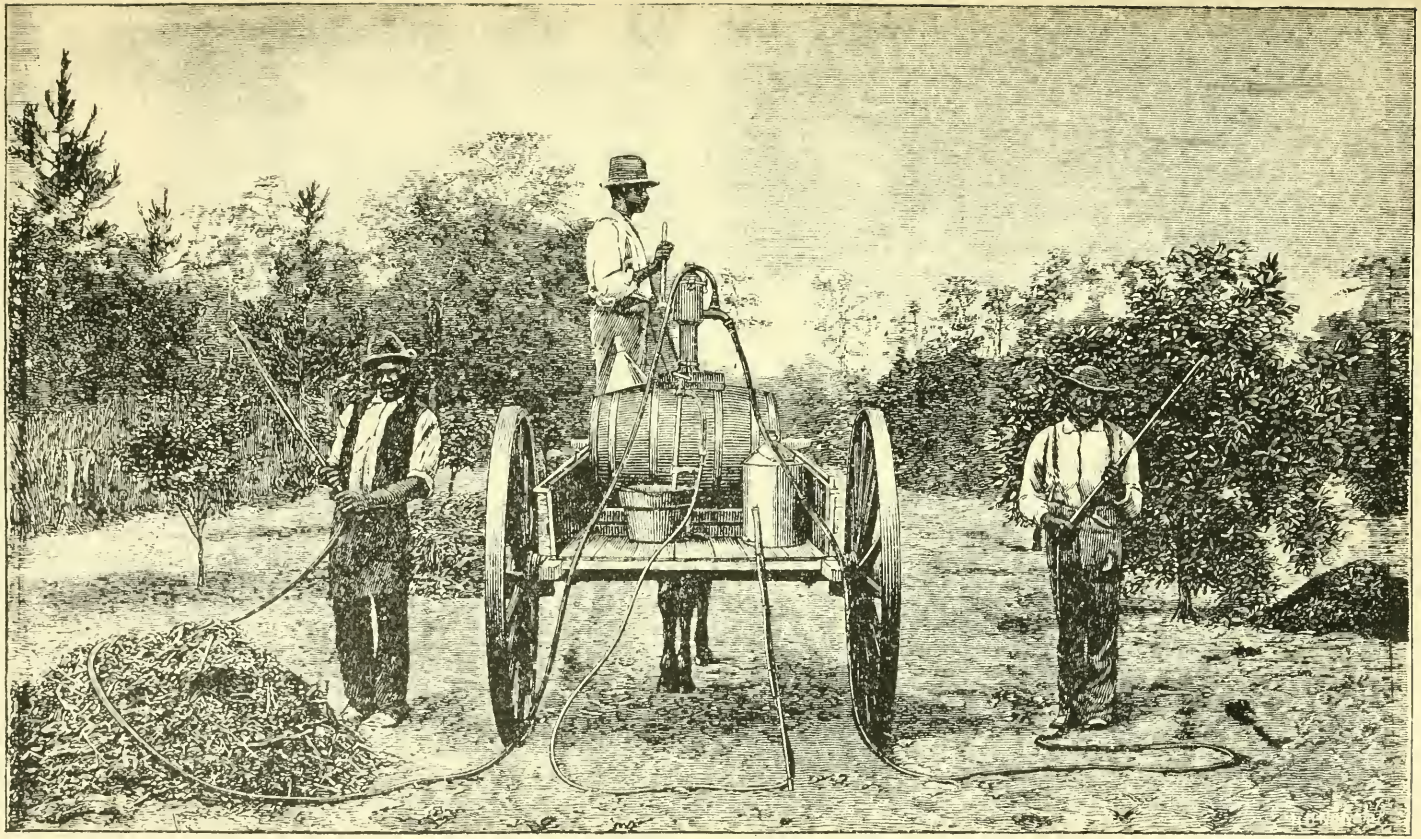


Fig. 12.—APPARATUS FOR SPRAYING ORANGE TREES.
Adopted in Florida, U.S.A., from a photograph; after Hubbard.



Fig. 13.—THE STRAWSONIZER.



Fig. 14.—FRENCH PORTABLE HAND SPRAYING MACHINE.

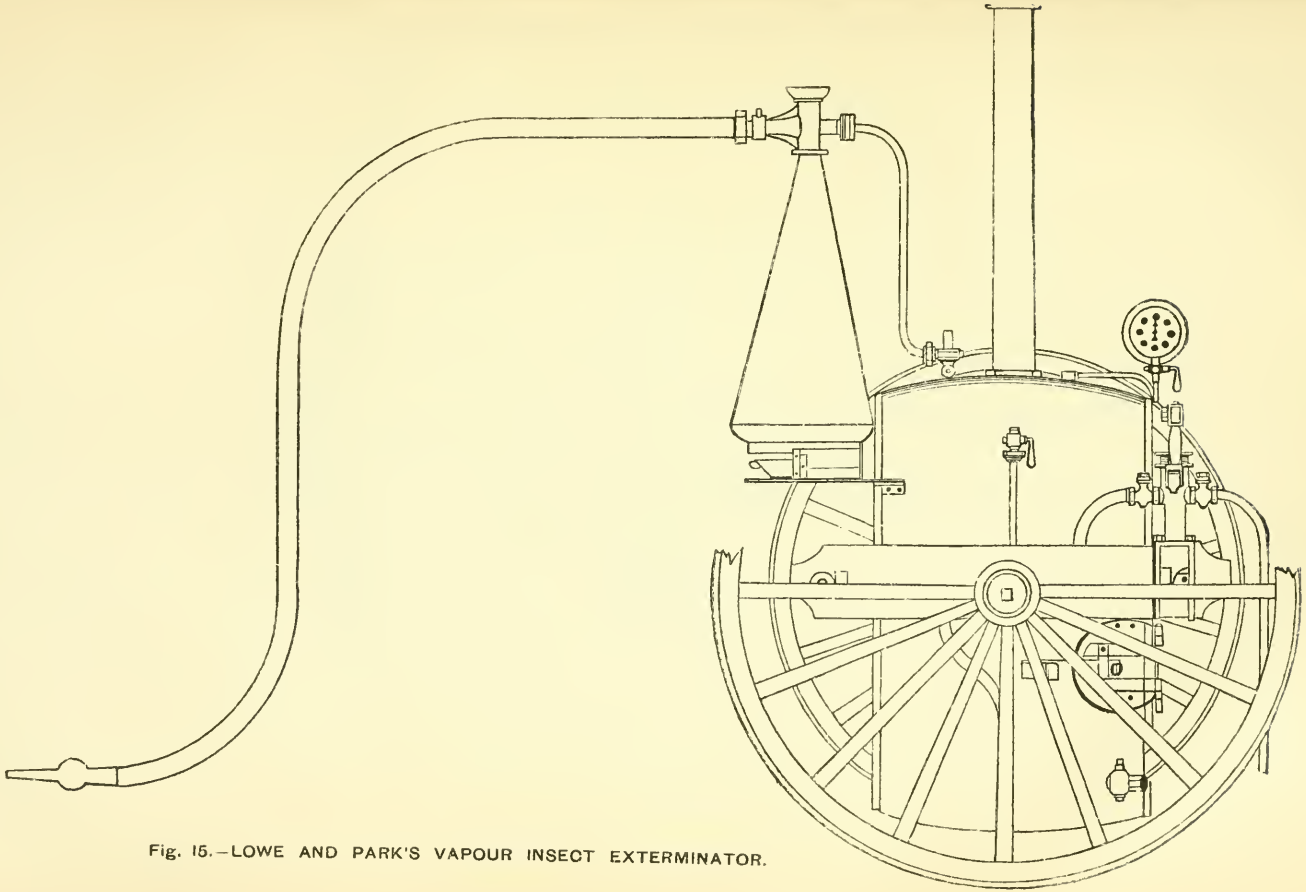


Fig. 15.—LOWE AND PARK'S VAPOUR INSECT EXTERMINATOR.

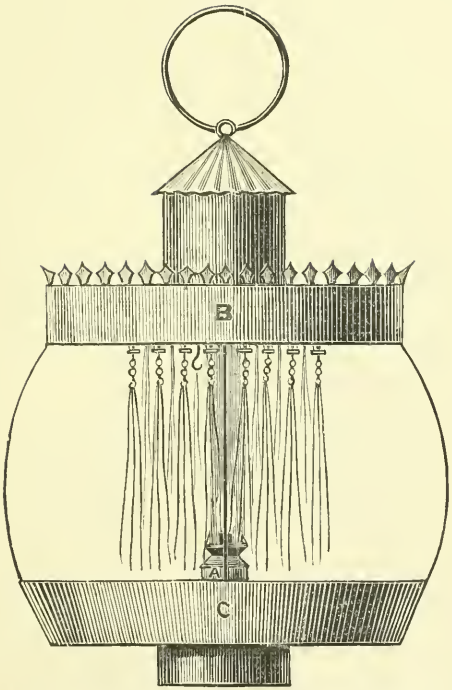


Fig. 16.—THE GREENHILL CODLIN MOTH LAMP.

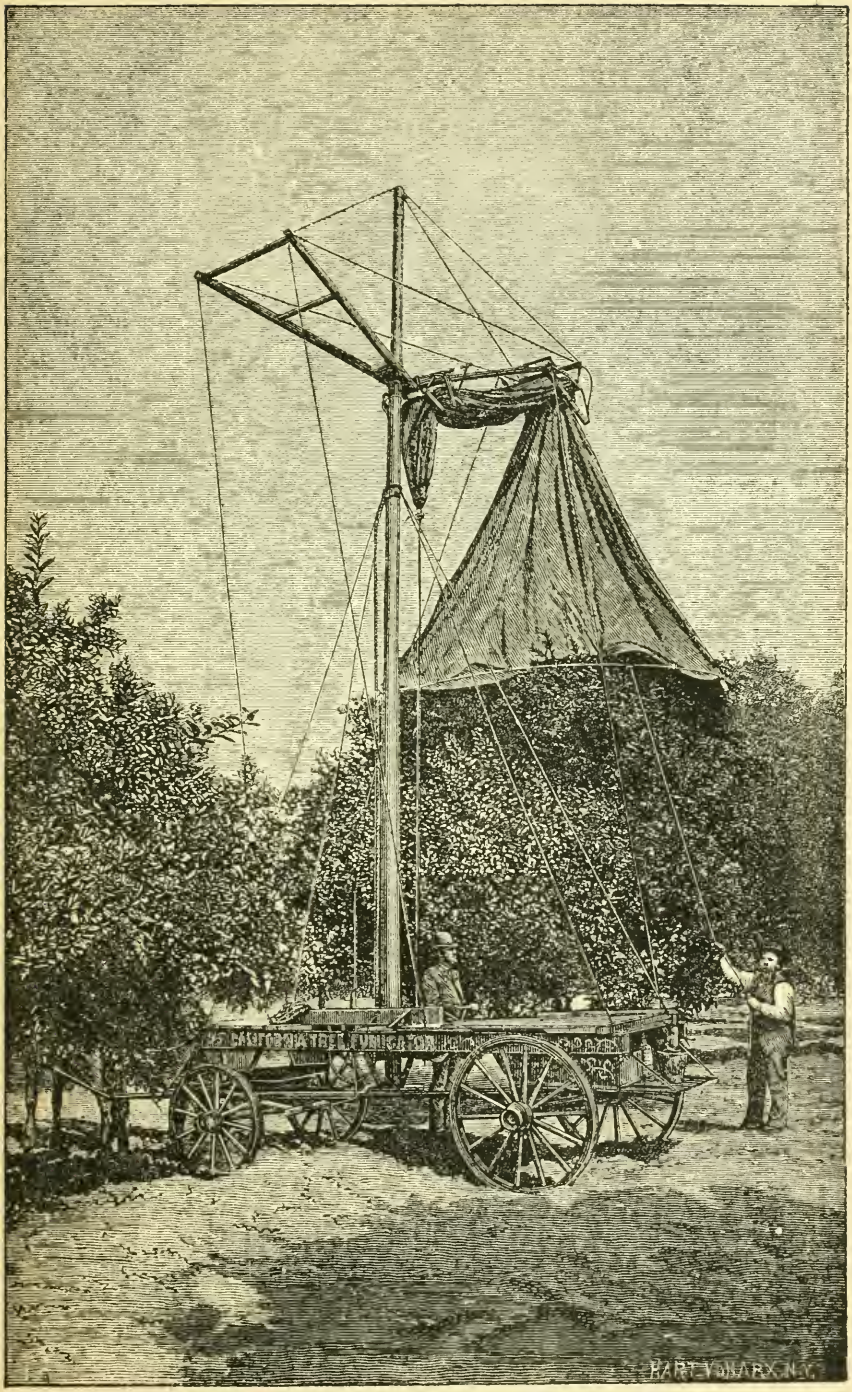


Fig. 17.—THE WOLFSKILL FUMIGATOR.



Fig. 18.—THE TITUS FUMIGATOR.

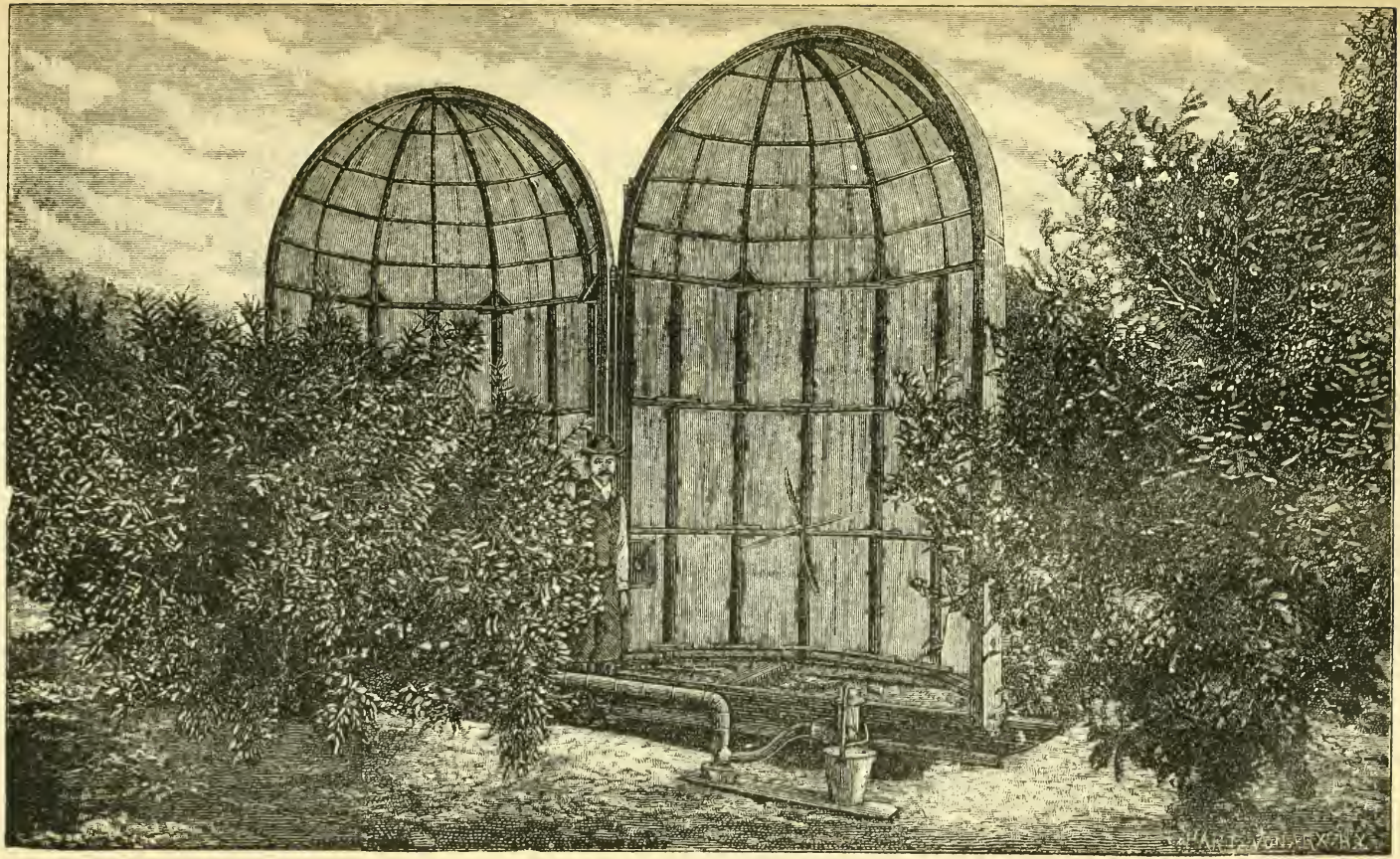


Fig. 19. THE CULVER FUMIGATOR

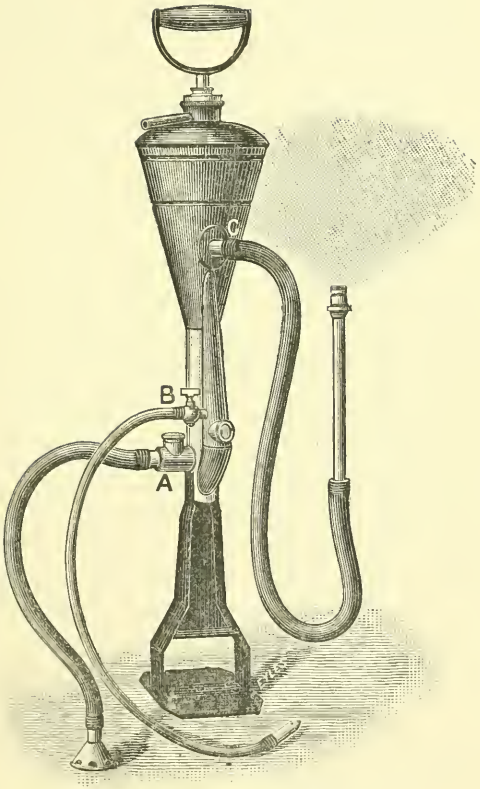


Fig. 20.—PATENT AGITATOR SPRAY PUMP

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